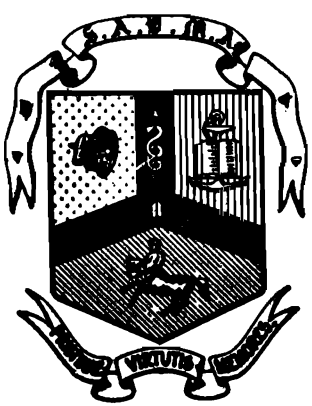
JOURNAL

OF

THE SOUTH AFRICAN VETERINARY MEDICAL ASSOCIATION

VOLUME 38 NUMBER 4
JAARGANG 38 NOMMER 4

DECEMBER 1967
DESEMBER 1967



TYDSKRIF

VAN

DIE SUID-AFRIKAANSE VETERINÊR-MEDIESE VERENIGING

Jl S. Afr. vet. med. Ass. 38 (4): 333-335 (1967)

ADDRESS AT THE OPENING OF THE SCIENTIFIC CONGRESS AND SIXTY-SECOND ANNUAL GENERAL MEETING OF THE SOUTH AFRICAN VETERINARY MEDICAL ASSOCIATION, DURBAN, 3rd OCTOBER, 1967

PROFESSOR O. P. F. HORWOOD

Mr. President, Your Worship the Mayor of Durban, Ladies and Gentlemen,

It is a great pleasure for me to be invited to open your Annual Congress, and I thank you sincerely for the honour you have done me by your invitation. My wife and I are very happy indeed to have this opportunity to meet you and the members of your Association and we should like to say at once that we think you have shown excellent discernment in choosing Durban as the venue of your Congress this year.

The history of the study of animal disease and the practice of veterinary medicine is a long and honourable one, as old and as honourable, I am sure, as the history of human disease. Of course, the two sciences have a great deal in common — though there are differences. This was illustrated by the American comic actor, G. Marx, in a film in which he appeared some years ago. He was playing the part of a vet — a horse-doctor, to be precise — but was mistaken by an admiring lady for a medical doctor. She complained of bad headaches and asked the doctor for a prescription. He reached into his pocket somewhat distractedly, and drew out a quantity of very large white tablets. "Madam", he said, handing them to her, "just take two of these every ten miles in a bucket of water, and you will be fine!".

The history of veterinary medicine may be classified roughly into three long phases. There are records going back to 1900 B.C. to prove that the science flourished in ancient Egypt and, about the same time, in ancient India; and, circa 1800 B.C., the legal code of the Babylonian king Hammurabi prescribed fees for "doctors of asses and oxen".

The ancient Greeks recognised a class of "horse doctors" and a number of writers (Hippocrates, 5th century, B.C., Xenophon, 5th century B.C. and Aristotle, 4th century B.C.) gave consideration to the systematic treatment of animal diseases. The Greek veterinarians of the Roman armies during the Byzantine period demonstrated a high level of proficiency, superior in some respects, it would seem, to that of the medical practitioners. Chief among these was Apsyrtus (± A.D. 330), whose writings mark him as the "father" of veterinary medicine.

Though the Romans were much less interested in animal diseases and their treatment than the Greeks, it was a Roman, Vegetius (± A.D. 450), whose great work, *Artis Veterinariae*, was to be the last important veterinary writing for nearly 1,000 years and the first influential veterinary work to be printed (Basel, 1528). Vegetius demonstrated a clear understanding of the importance of segregating "sick" animals as well as other principles of hygiene and preventive medicine. He also deplored what he saw as the already lowered status of the veterinary art and ridiculed the tendency to attribute animal disease to supernatural influences — a tendency which, he warned, if continued, could not but be a detriment to the development of animal medicine.

That is exactly what happened, so that throughout the middle ages, the study of animal diseases, and their treatment, fell into a considerable decline, so much so that there was a virtual standstill in veterinary knowledge extending from late Roman times down to the 18th Century. A major exception was Carlo Ruini's classic treatise, *Anatomia del Cavallo* ("Anatomy of the Horse", 1598), the first completely original work on the horse in 1,000 years, and which included a section on diseases.

The depredations caused by animal plagues during the 18th century in Europe forced a reappraisal of the methods of treating animal dis-

Die openingsrede tydens die twee-en-sestigste jaarkongres is waargeneem deur prof. O. P. F. Horwood, prinsipaal van die Natalse Universiteit. Saam met hom verskyn (van links na regs) Mev. A. F. Tarr, Mev. O. P. F. Horwood en Dr. A. F. Tarr, president van die S.A.V.M.V.

ease and ushered in the third or modern phase in the development of veterinary science. Most significant was the establishment of veterinary schools throughout Europe in the late 18th and early 19th centuries. With veterinary medicine once again in the hands of educated men, the profession rapidly regained its lost status and its development closely paralleled that of medicine. The methods and techniques of the one were readily adapted to the other, and with the realisation of the close inter-relationship of many human and animal diseases, human and animal medicine have come logically to be regarded as complementary.

One result of the recognition of this circumstance has been the increasing emphasis placed on the public health aspects of veterinary science, and I am interested to see that provision is made for a public health group in your conference programme.

Traditionally, veterinary public health has included the eradication and control of the diseases communicable between man and animal, and food hygiene — primarily the inspection of food products of animal origin. To these have been added industrial hygiene (including the prevention of air and water pollution and occupational diseases of handlers of animal products); radiological health, concerned with the biological effects of radiation; space medicine, involving research on the effects of high altitudes on the animal body; and animal cancer research as a

means of attacking the problem of cancer in man and animal.

I do not have to emphasize to an audience of veterinary scientists the great economic importance of preventive veterinary medicine and control measures to animal breeders, farmers and the general populace. A reasonably precise figure for the losses from animal disease in South Africa is not easily arrived at, but in the United States, where the statistical services are highly organised, it is conservatively estimated that the loss runs to some 10 per cent of the total value of livestock. What we can say with assurance, is that in S.A. the incidence is higher.

A major challenge to veterinary science today is the supplying of adequate services to the under-developed areas of the world. The plains of Africa, for example, could produce vast quantities of much-needed meat — and therefore protein foods — once the problems of animal diseases, such as tsetse fly infection, peculiar to this Continent, have been mastered. Except for most of the countries of Western Europe, the supply of veterinarians has not been adequate to meet the demand. To furnish these needs, a greatly increased output of broadly trained veterinarians by existing or new schools will be required.

South Africa stands poised to play a constructive and valuable part in many aspects of the development of emergent African territories, to their benefit as well as our own. By general agreement, medical and veterinary services are a top priority. But the question is: are we producing enough qualified veterinarians in South Africa to supply our own needs, let alone provide urgently needed assistance in neighbouring territories? On every side I understand the answer to be in the negative.

I am told that the present membership of your Association is about 560, of whom some 400 are actively engaged as veterinary scientists in the Republic, and about 60 are active elsewhere in Africa. West Germany, with a cattle population very similar to ours, has 8,000 veterinary surgeons. In the United Kingdom it is estimated that there is one veterinary scientist for every 3,500 livestock units — in South Africa there is one for every 30,000 and more livestock units (measured in cattle and sheep, excluding horses, pigs, poultry and goats).

In 1961, in his Presidential Address to your Association, Dr. H. P. Steyn made an eloquent and closely-reasoned plea for a second faculty of veterinary science in the Republic; and, three years later, in an address to the Natal Agricultural Union, my predecessor as Principal of the University of Natal, Dr. E. G. Malherbe, put the case — a very strong case, I suggest — for a faculty of veterinary science in the University of Natal at Pietermaritzburg.

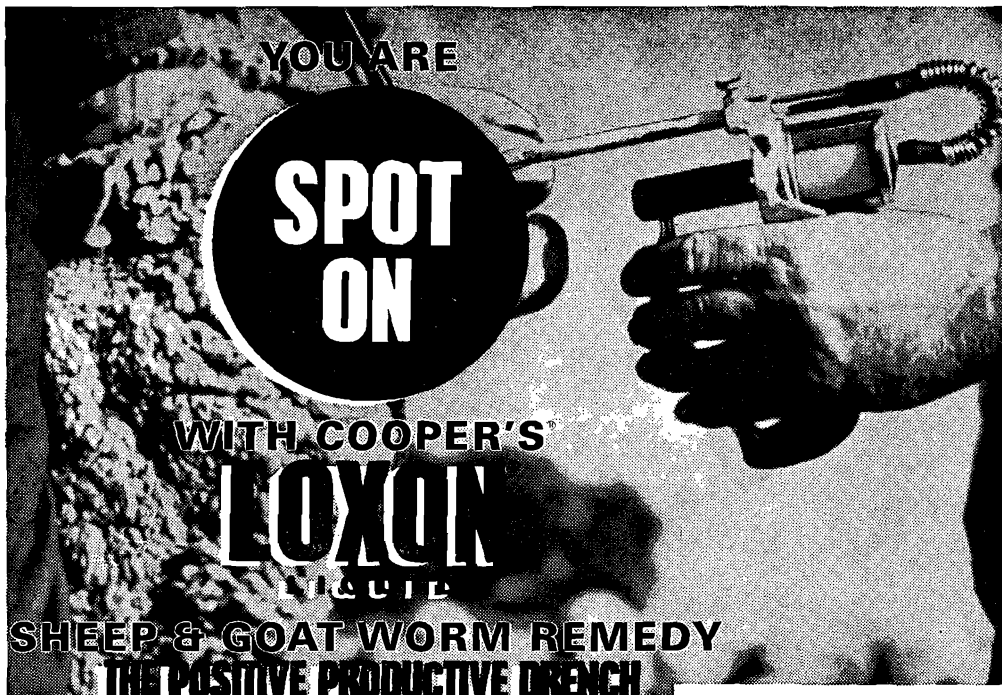
Nothing seems to have happened since then. Yet these matters are so important, not only for your profession, but for the country as a whole, that I trust your Association will look long and searchingly at the training facilities for veterinarians in South Africa, and make public your considered conclusions. Are you, or are you not satisfied with the position as it is?

May I make one other request, and that is that you look into the possibilities of providing veterinary training for non-whites. Until this is done I do not see how we in this country will ever be able to ensure an adequate supply of veterinarians for the population as a whole.

There is an eight to ten years time lag in the establishment of a new veterinary school and the production of qualified veterinarians, so that the time to start is now, I suggest. It may well be found feasible to turn out, in the early years, non-Whites with less than full qualifications who could perform valuable services in non-White farming areas and so obviate the disadvantages of the present complete dearth of non-White practitioners.

This is a matter requiring careful thought from experts like yourselves.

Meneer die President, met hierdie paar gedagtes wil ek u hartlik bedank vir u vriendelike uitnodiging aan my vrou en myself om vanoggend die verrigtinge van u kongres by te woon. Ons vertrou dat u die tyd hier in Durban baie sal geniet. Dit is nou met genoeë dat ek hierdie Wetenskaplike Kongres en 62ste Jaarvergadering van die Suid-Afrikaanse Veterinêr-Mediese Vereniging geopen verklaar.



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PRESIDENTIAL ADDRESS

A. F. TARR

It has been said that because of a tremendous population explosion the world is on the threshold of the greatest famine in history. This may be a bold and startling statement but let us consider the evidence.

Up to World War II the world population never increased by more than 1% per annum. There has been a sharp increase since then and today it is 2% and in some countries as high as 3%. The greatest percentage increases are in countries such as India, China, other Asian countries, parts of Africa and South America. Some of these countries will double their population within a generation. This high rate of increase will inevitably lead to a tremendous population explosion in these countries and they could be faced with one of the greatest famines of all time.

According to a survey conducted by F.A.O. in 1965, one third of the world population is undernourished and one half of the world population is underfed.

In the more economically stable countries, such as the U.S.A., U.S.S.R., parts of Europe, Canada, Australia and New Zealand, the growth rate is about 1% or less and it will thus take approximately a hundred years for the population to double. In the Republic the growth rate is about 2.1—2.5%.

There are two direct methods of averting this pandemic starvation. The one is to slow down the increase in the human population and the other to speed up the expansion of food production to feed the added millions. As we cannot pursue the first proposition, let us consider a few aspects of the latter.

In the less developed countries rapid population growth pushes up the demand for food when there is little new land for expansion. In other countries, including the Republic, vast areas of agricultural or food producing areas are being utilised for other purposes. This is a necessary development but it does create food problems. The emphasis will be on greater food production from less land and this necessitates more and more intensification of farming methods. Intensification brings with it a host of new problems and we will have to equip ourselves adequately to meet this challenge. The necessity for the mass production of foodstuffs of animal origin may not appear, to some, to be an urgent necessity, but we must realise that on the continent of Africa, we, by reason of our natural resources, wealth, talent and development, must assume the leading rôle. We will be called upon to provide not only for our own people, but for those in other parts of the African continent and elsewhere. This will require the utmost ingenuity of every organisation, especially those connected with agriculture.

In an address of this nature it is not possible to deal with the numerous factors affecting food production. There are, however, one or two thoughts which present themselves which I find intriguing, although I am not qualified to speak with an air of authority. It is all very well to talk about food of animal origin but one must remember that we are in constant competition with animals. For instance, it has been estimated that a dairy cow producing 9,000 lbs. of milk, or 900 gallons in 300 days consumes concentrates suitable for human purposes which could adequately feed six adults for 300 days. It is obvious, therefore, that the dairy animal and the beef animal must utilise food more economically and with less competition to man. Wherever possible, and this is governed largely by rainfall, the emphasis must be on pastures of a high quality and fewer grain supplements. New Zealand presents an excellent example in this regard. Even in this country individual farmers have achieved spectacular results by proper pasture and better farming methods. The establishment of pastures as the main source of food for livestock is slowly but surely gaining ground and the Departments responsible are to be congratulated on their achievements.

A recent visit to one of the largest game reserves in Southern Africa during a very dry spell enabled one to make an interesting observation. Without exception all animals seen were in excellent condition and there was obviously sufficient food in spite of the large numbers of elephant, giraffe, kudu, buffalo, impala, zebra and many other species. The secret must lie in their different feeding habits and utilisation of food. In this regard they appear to complement one another in contradistinction to farm animals, where the grazing habits are similar. Of all animals, game are the least in competition with man and it is possible that they will, in time become a very important source of food, especially as they can exist where domestic animals cannot survive. If properly controlled, their food supply should not be exhausted. In addition, they do present a tremendous tourist attraction.

The area of the Republic is about 300 million acres of which about 230 million acres are used for agricultural purposes. About 10% with a maximum of 15% of this land is suitable for cultivation; much of this is not of a very high quality when compared with land in other countries. It is, therefore, of the utmost importance that no more of this agricultural land be used for other purposes.

At the present time it is vitally essential for every individual, organisation, department, and every section of the public to exert, to the utmost, its talents and resources to the benefit of this country. If we, albeit a small country by population standards, are to play a major rôle and maintain a position of responsibility in the world we must accept the challenges confronting us. One of the essential requirements is the raising of living standards of all races in the Republic and in order to do this we must concentrate on productivity in the widest sense. For maximum productivity we must create the necessary incentive and climate. The position of any country in the world today is determined by its achievements in productivity.

Two essential and indispensible prerequisites are the maximum use of all available manpower and leadership. From the manpower point of view I feel that private enterprise is not utilised to the best advantage. In many spheres private individuals and organisations could be more closely integrated with official and semi-official undertakings. Private enterprise is not always motivated by the desire for material gain. It is also actuated by feelings of loyalty to, pride in, its country and is anxious to contribute its resources to the welfare of the State. On the other hand private enterprise must realise that co-operation is a two-way stream and that governmental control and regulations are designed for the common good.

Leadership is the ability to instil in the minds of subordinates a spirit of confidence, integrity and a feeling of being an essential part of the machine, no matter how insignificant the rôle. This point is well illustrated in a comment from Clarence Francis of the United States Food Corporation which reads as follows:—

> "you can buy a man's time, you can buy a man's physical presence in a given place, you can even buy a given number of skilled muscular motions per hour per day, but you cannot buy enthusiasm, you cannot buy loyalty and you cannot buy devotion of hearts, minds and souls. You have to earn these things".

Numerically ours is one of the smallest organisations in the Republic. It is, however, a well skilled and learned profession, hence greater responsibility is expected of us and greater demands are made upon us individually and collectively. A well trained veterinary profession is an important factor of national wealth, security and health. I submit with every confidence that our profession which figures prominently in research, education, field services, public health and private enterprise will play an important rôle and assume its proper place in the overall scheme for the advancement and self-sufficiency of our Republic.

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Jl S. Afr. vet. med. Ass. 38 (4): 341-344 (1967)

THE ROLE OF THE VETERINARY PROFESSION IN THE MODERN WORLD

B. C. JANSEN*

On many previous occasions, both in our country and abroad, the dedication to duty, the determination to increase the animal protein supplies of the world and the spirit of solidarity characteristic of the members of the veterinary profession have been emphasized. These common attributes have been earned under conditions varying from one country to another. Veterinarians still have to work under conditions dictated by the social and political environment and by the prevalent diseases — at the one extreme in affluent societies living in countries virtually free from animal diseases to the other in underdeveloped tropical countries plagued by scourges.

I wish to describe some of the conditions currently governing the activities of the veterinarian and I shall have to mention certain countries where the influences are of a local nature.

When the European Economic Community becomes fully operative, not only the trade barriers between the participating countries will be lifted, but also all existing restrictions on veterinarians to practise in any of the constituent countries. Practising veterinarians in countries where a high professional standard is maintained are concerned about the possibility of an uncontrolled influx of colleagues from countries with a lower standard and less opportunity for earning a satisfactory living. If this eventuates, unfair competition will result. On the other hand the establishment of the E.E.C. already has had the desirable effect of intensifying veterinary control over animal diseases and raising hygienic standards for food products derived from animals in some of the member countries.

In common with other professions, especially those of medicine, science and engineering, the veterinary profession faces the problem of obsolescence. Because of the tremendous expansion in knowledge, it becomes almost impossible to keep abreast of new developments in the wide field of veterinary science. Not only does the individual fail to keep up, but the curricula offered by veterinary faculties continue to improve to such an extent that the knowledge of practising veterinarians becomes obsolete within a few years. If veterinarians do not undergo retraining, their professional competence suffers and the quality of service they render to livestock producers is reduced. One way of overcoming this problem to some extent is by reading a great deal. But very few veterinarians have sufficient time to read enough to keep them well informed on all the latest developments; and current literature is not easily accessible to people working outside large establishments. Veterinary faculties fulfil a very important function by conducting regular refresher courses, although in general these are not as well attended as they should be. The reason for the poor support might be that few practitioners can leave their practices for any length of time without making special arrangements for the appointment of a *locum tenens* (who may not always be readily available). Is the solution not to be found in national bodies appointing to faculties specially suited men charged with the function of bringing the latest knowledge to practising veterinarians? They can disseminate information by conducting short courses in different geographic areas at times to suit the local practitioners.

The unprecedented explosion of scientific knowledge in the veterinary field, furthermore, has resulted in an increasing tendency towards

*Chief Veterinary Research Institute, Onderstepoort. Paper delivered at the 62nd Congress of the South African Veterinary Association, 2—6 Oct., 1967.

specialisation. People have specialised in subjects such as food hygiene, small animal practice and diseases of cattle. Specialist groups have been formed on a national and a world-wide basis; at the Congress of the World Veterinary Association held in Paris during July, 1967, much of the proceedings was occupied by sectional meetings with programmes arranged by specialist groups. It seems as if this development is fully justified and we as a veterinary profession in South Africa already recognise specialist groups within our Association. Nevertheless we shall have to ensure that fragmentation into completely dissociated groups does not result.

Great progress has been made in the biological sciences since the Second World War and even greater advances are expected in the future. Real accomplishments in these sciences however, can only occur if the biologists are provided with more suitable experimental animals. Veterinarians are not only competent to provide biologists with such experimental animals but are also adequately trained to study complex biological systems and their regulating mechanisms. Consequently, wide horizons have been opened for the employment of veterinarians and opportunities provided for them to prove that they can contribute materially to the study of biological sciences, so essential to the understanding of the complexities of life. Much has already been achieved, much more remains to be done.

Research in human diseases is severely limited by the fact that humans cannot be used for experimental purposes. Fortunately, for many a disease of man there is a similar and sometimes identical disease in some species of animal. Possibly the outstanding example is the occurrence of similar types of cancer in man and animals. Many nutritional disorders and degenerative processes fall into the same category. Both man and the horse are subject to chronic pulmonary emphysema and the lungs of the horse and of man are anatomically and physiologically similar. The result is that the horse can serve as a suitable model for research on chronic pulmonary emphysema in man. Studies conducted on the haemopoietic system of the ox have added much to our knowledge of haemopoiesis in general. Who would therefore deny that veterinarians have a very important rôle in basic research in the biological sciences? In the U.S.A. they have met the challenge under schemes sponsored by the National Institutes of Health. Some of the American medical schools are acquiring veterinarians with specialized training in laboratory animal medicine because they have realized the value of introducing comparative medicine into their research and teaching programmes.

As a natural result of increased labour costs, mechanisation and vertical integration have been applied to animal production and animals are being kept in large units. Beef cattle are fattened in feedlots in numbers of up to 30 000, large dairy concerns have displaced smaller dairies and broiler chickens are raised in vast numbers in single plants. In Australia there are farming syndicates keeping as many as 70 000 sheep. This concentration of animals has enabled veterinarians to care for larger numbers and to become specialised in the overall veterinary care of one type of animal. It has promoted professional skill and the large scale application of preventive medicine. Under such conditions veterinarians are most profitably employed in performing only those tasks requiring advanced skill and training. At the same time the need for veterinary aides or assistants to perform the tasks of a repetitive nature has emerged. The need for a person with sufficient training to relieve the veterinarian of routine tasks is fairly widely felt, but has created some problems in certain professional circles. The level at which a veterinary assistant should work and his status in relation to a qualified veterinarian have not yet been defined clearly. These matters are still controversial.

In many advanced countries horses no longer serve as working animals but are regarded as pets and like cats, dogs and budgies have attained a sentimental value which, with some justification, could be regarded as unrealistic. To illustrate this humanistic approach one may cite the treatment of a dog with diabetes mellitus for prolonged periods and at high cost with insulin for the sake of keeping it alive (not that it is ever a happy animal during this time), or the performing of a most advanced and specialised operation on a cat for the removal of a brain tumour. I presume it is a natural tendency for veterinarians to render this type of service as the available techniques become more and more advanced, but I think that we as a veterinary

profession in South Africa with our traditional sober outlook should do some very serious thinking on the prudency of following this approach. Is it not part of a scientific approach to be realistic?

Disease recording is enjoying increased attention in progressive clinical departments and programmes have been developed for using I.B.M. systems in drawing up disease profiles. This development greatly facilitates the study of epidemiology and has already indicated that many problems in the purely veterinary field remain to be solved. The greatest loss results not from the spectacular epizootic diseases, but from the enzootic diseases of parasitic, infectious, nutritional, toxic, metabolic or organic origin that continually prey upon the livestock population. Some of these conditions have long been known to us, others have only recently been shown to be of significance. A few of the salient conditions in the latter category as well as some interesting research results will be mentioned:

(1) In the U.S.A. Beagles are bred on a large scale by private concerns and sold to research establishments for experimental purposes (at a price of about $75 per animal). About two years ago some of the producers experienced serious breeding difficulties with their animals. Their dogs became sterile and the bitches aborted. As a result of a careful investigation it was found that a *Brucella* organism closely related to *Br. ovis* is responsible for the condition. After infection a long period of bacteraemia results and the affected animals become lethargic. Bitches abort at various stages in pregnancy and the foetuses, foetal membranes and uterine excretions contain large numbers of bacteria. Dogs develop epididymitis with pressure atrophy of the testicles.

(2) The P.P.L.O.'s (*Mycoplasma* spp) have gained a prominent position as pathogens. Apart from pleuropneumonia of cattle and goats and agalactia in goats, they have been proved to be the cause of enzootic pneumonia of pigs, mastitis and metritis in cows, joint lesions in lambs and eye infections in goats.

(3) Spectacular information about the behaviour of foot-and-mouth disease virus has become known. The virus can be cultured from specimens collected by means of a probang from the pharynx and oesophagus of cattle for about 16 months after recovery from the disease. The virus titre of the material thus collected can be increased materially by treating it with trifluorotrichloro-ethane. It is believed that this compound has the action of splitting an antibody-virus complex, thus releasing virus particles. The carrier state can also be produced experimentally by vaccinating cattle with dead or live vaccine and then infecting them with virulent virus. Vaccine virus was found in probang specimens from calves born to cows vaccinated during pregnancy. No contact transmission of the virus occurs from carriers to susceptible animals under experimental conditions. Epidemiological evidence, however, does create the suspicion that carrier animals can be the source of new outbreaks in nature. Is there a factor in nature which can split virus-antibody complexes?

(4) In Britain it was found that in some piggeries where crystal-violet swine fever vaccine has been used and in some where this vaccine has not been used, many piglets develop a disease best described as "trembling". The following theory has been advanced to explain this phenomenon. When a sow, partially immune, as a result of an injection of crystal-violet vaccine, becomes infected with virulent virus or when a fully susceptible sow becomes infected with a virus of reduced virulence, the virus multiplies in her blood, and passes into the foetuses if she is pregnant. The virus does not kill the sow and continues its multiplication in the foetuses. The sow develops antibodies and becomes immune; the foetus does not develop antibodies but an immune tolerance since it accepts the virus as part of itself. The virus persists in the foetus: it has actually been recovered from foetuses and live piglets. Depending on the stage at which the virus enters the system of the piglet, a varying degree of damage to the central nervous system is done, consisting of hypoplasia of the cerebellum and demyelinisation of the spinal cord. These lesions are responsible for the trembling syndrome.

Britain has stopped using crystal-violet vaccine and started an eradication scheme. The finding of trembling piglets with demyelinisation and of sows with antibodies in their sera has

been taken as proof of the presence of live virus. The slaughtering of the pigs on such farms has already met with remarkable success in reducing the incidence of the disease.

From what I have said it is obvious that the veterinary profession is currently faced with many unsolved problems, but at the same time more opportunities for proving its worth are than ever before. We as South Africar narians are fully competent to meet th lenge and of availing ourselves of these tunities. Let everyone therefore ask him question: Are we as a profession doing expected of us?

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Jl S. Afr. vet. med. Ass. 38 (4): 347-352 (1967)

FARM PLANNING AND PASTURE MANAGEMENT AS THEY AFFECT THE VETERINARIAN

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INTRODUCTION

The problem of soil erosion has long been posed as the most important problem with which South African agriculture and, indeed, the South African public is faced. Much has been written and preached on the urgency of the problem but the fact remains — as stated by Dr. J. C. Ross at a recent meeting on Soil Conservation Education in Southern Africa — that the *tempo* of soil erosion is far greater now than it was twenty one years ago when the Soil Conservation Act was passed.

At the same time the need for markedly raising the production of food to meet the needs of a population which is increasing by geometrical progression, is continuously being stressed.

Here, then, are two problems and it is not possible to overcome the second until the first has been solved. It is a well known fact that as soil erosion increases and the productive top soil is lost, so our rainfall becomes less effective, droughts become intensified, the production of food per morgen from our arable land and the carrying capacity of our veld drops so that the production of meat, milk and wool per unit area lessens. Bound up with this are stock losses of various kinds connected with malnutrition, plant poisoning and diseases such as "geeldikkop". Attempts to meet the demand for more food have led to various improved practices such as better fertilising of crops, new hybrid varieties and provision of irrigation on a large scale, but a losing battle will be fought unless the soil erosion problem is seen in the proper perspective and is tackled on a nation-wide scale in a realistic fashion.

For a while it was thought that soil erosion could be combated by mechanical means: by the building of dams, by the erection of contour drains or banks, and by attempting to stabilise dongas, but it was not long before it was realised that it was the symptom of the disease that was being treated and that the real solution lay in removing the causes. Pentz[1] maintained that the most important cause of erosion was wrong land use — usually due to over-intensification — and that land use was often erroneously determined by economic factors when, basically, it should have been determined by ecological factors. He postulated that farming could be divided into three main groups of land use: extensive, where the main reliance for production should be on the veld, semi-intensive where the main reliance for production should be on the veld supplemented by arable land, and intensive, where the main reliance for production should be on arable land, either through crops or cultivated pastures, or both. He stated that, as shown on diagram 1, the ecological factors of climate, soil, topography and vegetation, of which the last was often an indicator of the others, should be used to determine land use. Under climate he used rainfall in which he had two groups — high or well distributed, and erratic or low, — under soils he had arable and non-arable (depending on erodibility and drainage), under topography he had open and rolling, or broken, and under vegetation he had forest and grassland or savannah and desert, i.e. each factor was either in the optimum or not. If all four factors were in the optimum, the land was suitable for intensive farming. If one were not in the optimum, the land was suitable for semi-intensive farming and if two or more were not in the optimum, the land was suited for extensive farming only.

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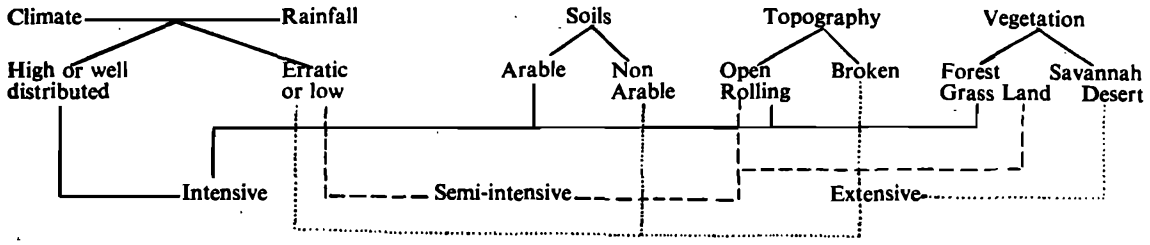

Diagram 1: Land use according to ecological factors. Adapted from Pentz (1945).

Where irrigation was introduced into any area in which the soils were suitable, the land use should then be altered to intensive as shown in diagram 2.

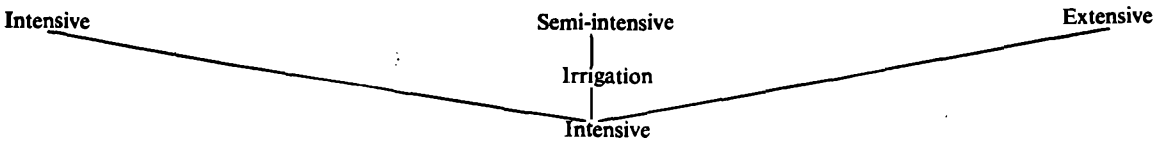

Diagram 2: Land use can be altered, as shown, by introduction of irrigation.

Once the land use has been determined on the basis of the ecological limiting factors and this is applied in practice, most of the causes of erosion will have been removed and the planning of economic factors — super-imposed on the correct land use — will lead to the increase in production which is so badly needed.

Much research has been carried out on the various practices which fit into a correct pattern of land use and there is a great deal of information available. Farm planning has been widely publicized and carried out under the Soil Conservation Act and the State has spent a great deal of money in subsidizing farm planning, and yet erosion is on the increase. This is due to the fact that a great deal of lip service is paid to conservation but the knowledge available is not being applied. The physical planning of the farms is being carried out on a very wide scale but the measures which should improve the farming are not being applied.

My idea is now to deal with the three aspects of land use planning — extensive, semi-intensive and intensive — to show how they should be applied and to indicate the problems which they in turn may create for the veterinarian.

Planning in Areas Suited to Extensive Farming

Extensive farming, according to Pentz, should be practised in those areas in which, due to the environmental factors, reliance for production should be entirely on the veld. Farm planning should thus be aimed at veld management with proper systems of resting the veld in order to obtain vigour and produce as good a cover as possible. The provision of water in the camps becomes a matter of considerable concern because, if water is not available at strategic spots, it may not be possible to make full use of the herbage produced and excessive trampling to and from the watering spots may lead to erosion. The limitation of stock numbers to the carrying capacity of the veld should also be one of the provisions of the planning. Many farmers have made full use of the facilities provided by the Department of Agriculture in the subsidisation of the cost of fencing and building of dams but painfully few have carried out the recommendations with regard to the management of the veld which should be applied. Many of them have accepted assistance because it made it possible to increase the capital value of the farms to a marked extent at relatively low cost to themselves, while others seem to think that the provision of a number of camps in itself reduces soil erosion. As one farmer stated at a public meeting which I attended: "I used to have one camp on my farm. Now, thanks to Soil Conservation, I have twelve and I can now run twelve herds or flocks." This showed what I think is a fairly widespread lack

of the grasp of the essential ideas underlying soil conservation planning and veld management. There is a considerable body of knowledge on the management of veld, whether to burn or not to burn and the correct time of burning, should it be necessary, but little heed is paid to these. It may be due to the fact that improvements are not spectacular — such as may be obtained by sidedressing of maize with nitrogen in intensive areas — and a farmer is unwilling to carry out practices — either changing old ones or trying out new — which do not show spectacular improvements in production.

Of late there has been a great revival of interest in veld management due to the claims of the protagonists of "non-selective grazing" systems who maintain that by these systems it is possible to double or treble the carrying capacity of the veld. While there is much to commend in these systems in certain areas, there is a great danger of overstocking where the promised improvement in the veld, and hence in carrying capacity, do not occur immediately. But here the farmer forgets three things — firstly, by having his farm planned and accepting assistance in the form of fencing or provision of water supplies, he is already in a position to carry out such improved practices without further cost; secondly, that without proper systems of resting and grazing, his veld becomes a wasting or deteriorating asset and sheet erosion is an ever present menace. Where he applies proper systems of management, he not only reduces erosion but maintains and improves the production of herbage from his veld; thirdly, with proper management, he reduces the effects of drought as there is more feed to go round and because there has been better penetration of the rain into the soil, it is more effectively used. In addition to this, there is less danger of stock losses from various causes. Where veld is badly eroded — and, as mentioned earlier, sheet erosion is probably the more important and more insiduous in the extensive farming areas — there is not enough grass cover on the ground and, when the rains come, many undesirable plants, which would otherwise be checked by the grass, become dominant. Possibly the most important of these is *Tribulus terrestris*, the "dubbeltjie", an alleged cause of "Geeldikkop" in sheep. Very often, due to the fact that they have bulbs or deep root systems, poisonous plants begin to develop earlier than the grasses and, in the absence of the latter, stock graze these plants and die of plant poisoning. Typical examples of this are "*Urginea* spp. or "slangkop" and *Dichapetalum cymosum* or "gifblaar". Good, planned veld management can reduce the danger by allowing camps infested with such plants to be rested during the spring periods when they are most dangerous and by providing more competition from the grasses by proper systems of rest. Furthermore, the condition of the livestock in eroded areas is usually poor during the winter or in times of drought and animals under stress are much more prone to succumb to parasites. Where proper veld management is practised, there is much more feed for the lean periods and stock remain in better condition with the result that they are less likely to be seriously affected by parasites.

There is thus no doubt, from whatever angle the matter is approached, that the planning and carrying out of proper systems of land use are well worth while. There has been much stress placed in the past on the necessity of combating or preventing erosion but not enough on the reasons why it is worth while in terms of rands and cents. It is also clear that if erosion can be reduced to a minimum and a good grass cover be restored, the work of the veterinarian in such areas will be much reduced.

Planning in Areas Suited to Semi-Intensive Planning

According to our definitions, given earlier in this paper, areas suited to semi-intensive farming have some limiting factor which makes it necessary to rely mainly on the veld for production but supplemented to a certain degree by production from arable land. This means that such country, like the extensive areas, is suited primarily to livestock production and, while small areas of cash crops may be grown, the arable land is usually required for the growing of fodder crops for hay and silage.

In these areas there is often a tendency to plough land which is not really suited for agriculture — due to rainfall, soil type, or slope — and such areas as a rule are affected to a marked extent by both donga and sheet erosion. The selection of *suitable land only*, as allowed for under the Soil Conservation Act, should receive far more attention from those responsible for planning. Proper protection of such land by

mechanical devices such as contour drains or ditches is carried out by many farmers but it is astounding to see in how many areas the most elementary precautions against erosion, such as ploughing only on the contour, are completely ignored.

Many of these areas are those in which provision for winter feeding should be made through the production of conserved feeds such as silage and hay but not nearly enough is produced and, instead, the veld is burned in autumn or winter, in the hope of obtaining out-of-season grazing. This is a very widespread practice, which results in exposure of the soil for long periods to desiccation and wind erosion, and which affects the penetration of water into the soil when the rains do come, leading to sheet erosion. This early burning leads to the increase in the number of bulbous plants in the spring, many of which are poisonous. Amongst the most important of the poisonous plants which account for large stock losses, particularly of lambs, is *Senecio retrorsus* and while no method of veld management has yet been devised by which the indigenous grasses become dense enough to compete successfully with it, there is every reason to believe that were the stock not put into the veld so early in the spring when it is particularly evident, there whould not be these losses. There is the case of a prominent farmer in an area where senecio was prevalent who grew large areas of *Eragrostis curvula*, not only to provide hay during the summer but, as it is one of the earliest grasses to shoot in the spring, to provide green grazing at the time of the year when senecio poisoning was most prevalent.

As in the case of extensive areas, the main veterinary problems occur as a result of erosion and veld deterioration and where proper planning and carrying out of the plans, particularly for veld management, are practised, the worries become less. The part which can be played by the production of dryland cultivated pastures, particularly those grown as leys, could make a big contribution to the development of the semi-intensive areas.

Planning in Areas Suited to Intensive Farming

In the areas where reliance for production is mainly from the veld or veld supplemented to a certain degree by arable land, the ecological factors of the environment determine the maximum level of production which can be expected under sound systems of management. Manipulation by good or poor management can affect the plant cover, the amount of erosion, the type of plant which is produced and the problems of animal health. As erosion is decreased and management is improved, so the problems of animal health are more easily solved. When we come to consider the areas suited to intensive farming, however, the shoe is on the other foot. Here the ecological controls do not play the same part and many artificial or man-made factors come into play. By manipulation of soil moisture, fertility of the soil, the crops or pastures that are to be grown and the type of livestock to be carried, highly intensive production can be brought about. While the extensive and semi-intensive areas will produce a large amount of food and animal products due to their size — they comprise nearly 85% of the total area of the Republic — it is from the potentially intensive areas that the greatest increases in production are to be expected. The reasonably high rainfall areas of the Transvaal, eastern Orange Free State, Natal and eastern Cape can be developed out of all recognition, and provision is being made for irrigation on a larger scale than was ever before envisaged.

But with the introduction of new methods for highly intensive production, new problems are sure to appear and, in the planning of the new development, this must be realised and preparations must be made to meet them as they arise.

Sears[2], discussing the intensification of pasture development by the use of clovers in New Zealand, showed that the potentially extensive land required management of grazing and control of erosion but that the potentially intensive land first ran into the problem of primary nutrient deficiences. After this came the problem of bloat and then, as fertility was built up, came further diseases such as staggers, facial eczema and nitrate poisoning.

Gordon[3], writing on the Snowy Mountain scheme in Australia, pointed out that ecological changes resulting from expansion of irrigation would be profound and not always helpful to the farmer. He pointed out that vectors of disease organisms would be multiplied, stock would be denser on the ground and there would be a greater risk of spread of infection. He

stressed the need for timely survey studies and research to ensure optimal use of resources.

A similar stage is being reached in this country today and this Conference will be dealing with the need for studying these problems. In this paper, an attempt is being made to view the developments from the aspect of the pasture man and to show how the use of pastures, while doing much to increase not only animal production but the productivity of the soil, will create problems for the veterinarian. It will be necessary for them to work in close collaboration so that problems can be solved as they arise and, if forewarned means being forearmed, this country should be in a fortunate position.

In areas suitable for extensive or semi-intensive land use, the factor of gravest concern is that of soil erosion. In the highly intensive areas, with the need to conserve and work the land, the problem is soil fertility and this brings other problems in its wake. The part that pastures can play in the intensive areas is an important one. Even in areas which, according to definition, are suited to semi-intensive farming due to excessive slopes, pastures can be used to make them highly intensive as such pastures can be used to replace the natural vegetation. In this way high producing swards, which will respond to fertilisation in a way that the natural veld will not, can play a most important rôle.

There is quite a big selection of grasses and pasture plants which can be grown in the intensive areas but, by a careful system of elimination, it is possible to reduce the list to a few which can then be used. The first step in elimination is the ecological range: the moisture and temperature conditions which pertain on the selected sites. The next is the longevity required for the pasture: is it to stay down for many years, a few years or be grown as an annual? After that the purpose for which the pasture is intended must be determined: is it to be used for grazing, for hay or for silage or to build up productivity of the soil? Methods of establishment have been studied under different conditions and, although there is still much to be done on the introduction of legumes into the veld, much is known today about the correct procedures of pasture establishment which was not known a few years ago. Then comes the question of fertilising of the pastures and this varies with the composition of the pastures: whether they are composed of grasses and legumes or grasses only, the soil characteristics, the use to which the pasture will be put and the production that is desired. Pastures are expensive crops to grow. At one time the common idea was that they were to be established (if possible) on lands which were so depleted that nothing else could grow and then they had to fend largely for themselves. Today the picture has changed. Pastures are now often grown on good soils and are fertilised in a manner which will give big returns. Up to 70 tons of silage per morgen have been obtained from well fertilised Kikuyu, up to 11 tons of hay per morgen have been obtained from well fertilised *Eragrostis curvula*, carrying capacities of up to three cows per acre have been achieved on some farms and on a certain farm the average milk production from 120 cows in milk has been 3.5 gallons per day on pastures and pasture silage alone. Where there is irrigation, it is possible to produce pastures in summer and winter and to grow legumes which build up soil productivity. Summer carrying capacities on irrigated pastures have been as high as nine beasts per morgen for eight months of the year!

This type of high production leads to various problems of particular interest to the veterinarian. I would like to touch on a number of them very briefly as I think it likely that many of them will be themes for further papers at this conference.

These problems I, as a pasture man, would divide into two groups. The first group is one in which the genetically controlled properties of the pasture plant are such that they have ill effects on the animal. Here I would mention such plants as *Phalaris tuberosa* which produces "phalaris staggers", *Festuca arundinacea* which produces laminitis and *Paspalum dilatatum* which is very susceptible to infection by the fungus *Claviceps purpureum* which causes poisoning in stock. Why I classed these as genetically controlled is that, while it is possible to reduce paspalum poisoning to a minimum by management of the grazing of the pastures, it should also be possible to breed new varieties which are not particularly susceptible to the disease. In the case of *F. arundinacea* a new variety, Kentucky 31, which was bred a few years ago, is said to be free from the constituent which leads to laminitis.

Whether the same holds for *P. tuberosa* I am uncertain, as it may also fall into the next group.

The second group, I classify as one in which the ill effects are brought about by management. This group again I divide into two. In the first sub-group treatment or management of the pasture produces various metabolic upsets in the animal. The primary type of management bringing this about is usually very high or unbalanced fertilising which, in turn, upsets various balances in the soil and in the animal. (Here I need not go into those which affect the plant only.) Under these metabolic upsets I class bloat, on which much work has been and is being done in different parts of the world, trace element deficiencies and toxicities, such as grass tetany, nitrate poisoning and facial eczema on ryegrass. A great deal of work has been done in other countries on the effects of iron, copper, cobalt, molybdenum, zinc, manganese, iodine, fluorine and selenium. Deficiencies of the latter, I believe, are causing more and more white muscle disease in areas of high intensification in this country. You will hear today of what is being done in this country but there is still a big field for future work.

Grass tetany (hypomagnesaemia) and nitrate poisoning are receiving much attention in parts of the world like Holland and Britain, where very high fertilising with nitrogenous fertilisers takes place, while facial eczema occurs on very lush pastures in New Zealand. I have not yet come across these here personally, but we must be aware of the conditions under which they occur and be prepared to meet them.

These problems are not those of the veterinarian alone, as they are induced by management: the pasture man and the veterinarian will have to work in close collaboration if success is to be achieved.

In the second sub-group under management intensification leads to stock losses due to parasites. Lush pastures with plenty of moisture and high temperatures provide ideal breeding grounds for parasites. At the same time, the density of animals on the ground is such that infection is easily passed on. Here is a problem where management of the grazing by the pasture man will have to depend on a knowledge of the life cycles of the different parasites and collaboration with the veterinarian, so that systems of management of the pasture can be devised to reduce infestation to a minimum.

Conclusion

It is evident that in areas suitable for extensive or semi-intensive farming, animal diseases are often the result of poverty and this, in turn, is due to erosion. Therefore an all-out campaign against erosion is the best approach to the reduction of stock losses. The veterinarian must be just as keen a soil conservationist in his approach to his subject as the pasture officer.

In the intensive areas, animal diseases are more and more the effects of plenty. As more intensification takes place, so the problems will be accentuated unless steps are taken in time. It will be necessary for the plant breeder, the pasture officer and the veterinarian to work in close collaboration: only in this way will we be able to make the maximum use of our resources.

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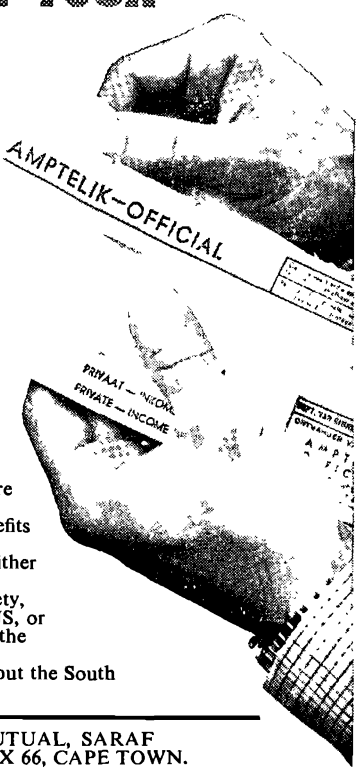

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TRACE ELEMENTS IN NATURAL PASTURES

F. J. VAN DER MERWE and I. S. PEROLD*

INTRODUCTION

The finding[1] in 1928 that copper is essential in the nutrition of mammals, opened a vast and very rewarding field of investigation. After forty years the voluminous literature on the subject of trace elements in animal nutrition is still growing and our understanding of the vitally linked series of processes which, in the mineral nutrition of farm animals, lead from the soil through the plant to the animal is growing daily. Thus Australian workers[2, 3] proved in the 1930's that a deficiency of cobalt in certain Western Australian pastures was the cause of the "enzootic marasmus" characterised by diminished appetite, wasting in condition and a high mortality rate in cattle and sheep. Years later, in 1948[4, 5], it was shown that cobalt formed an essential part of the vitamin B_{12} molecule and from this it was inferred that the physiological functions of cobalt in the animal were essentially the same as the functions of this vitamin. Another thirteen years elapsed before Marston, Allen and Smith[6] could complete the picture in respect of cobalt and vitamin B_{12} in ruminant nutrition and cast the light specifically on the loss of appetite and wasting associated with cobalt deficiency. In an elegant series of experiments they showed that vitamin B_{12} has vital functions in the utilization of the important end-product of carbohydrate fermentation in the rumen, propionic acid. The deficiency of cobalt in the soil, or in some instances the inability of plants to accumulate sufficient cobalt from certain soil solutions, leads to a lowered production of vitamin B_{12} in the rumen. This in turn leads to the inability to utilize and remove from the blood stream the important energy yielding propionic acid.

In the Western Cape Province, Van Rensburg[7] suspected as far back as 1938 that some or other nutritional factor was responsible for the lack of normal crimp and resulting lower quality in Merino wool produced on the sandy, calcareous coastal strip. Swart and Van Rensburg[8] and later Perold, Swart and Van Rensburg[9] carried out a series of dosing experiments with sheep in the coastal area. The response of the animals to copper, cobalt, iron, manganese and zinc supplied in different combinations and in varying quantities was tested. These experiments showed that the loss of crimp in wool as well as the occurrence of "lamkruis" (swayback) in lambs could be prevented by a regular supplement of copper sulphate. In a comprehensive investigation of the aetiology of swayback Schulz and van der Merwe of Onderstepoort in collaboration with Swart and van Rensburg at Stellenbosch[10] showed that the occurrence of this nervous disorder was linked to the low copper concentration in the pastures (2–4 mcg Cu/g DM) and in the livers of animals from the affected flocks (2–25 mcg Cu/g DM).

At Stellenbosch, Perold, with his co-workers and post-graduate students, have continued the trace element investigations over the past twenty five years. Three main aspects received attention, viz. the trace element content of natural pastures in the Winter Rainfall Area as well as other localities in the Republic and South West Africa, the response of grazing animals to trace element supplementation and, thirdly, practical methods for supplementing trace elements to grazing animals. Thus it was shown[11] that pastures growing on soils of Table Mountain Sandstone origin in the Humansdorp district were deficient in cobalt and that the regular supplementation of sheep with salts of this element improved rate of growth and condition. It was shown[12, 13] that at George on the southeast coast and Langebaan on the west coast, sheep

*The Stellenbosch-Elsenburgh College of Agriculture of the University of Stellenbosch. Paper delivered at 62nd Congress, S.A.V.M.A., Durban, Oct., 1967.

grazing on *Phalaris* species developed symptoms typical of the condition known in Australia as "phalaris staggers."[14] As was found in Australia, this condition could be prevented by supplying additional cobalt. In a further study, Perold[15] prepared complexes of copper and cobalt which were soluble in alkaline drinking water and showed that these could be used successfully for the prevention of copper and cobalt deficiencies.

The Significance of the Trace Element Concentration of Natural Pastures and Factors Affecting it

Trace elements and their functions in the animal become of practical and economical importance only when a deficiency or excess is reflected in deviating animal behaviour, a lower rate of production, a recognisable disease syndrome and higher than normal rate of mortality. It is now accepted that farm animals require traces of iron, copper, manganese, cobalt, zinc, iodine, molybdenum, selenium and fluorine in their diet. Under natural grazing conditions, deficiencies of copper, cobalt, manganese, iodine and selenium have been demonstrated, while excesses of copper, molybdenum, selenium and fluorine in pastures have proved detrimental to stock in different parts of the world.

In considering the trace element content of pastures as an aid to the diagnosis of deficiencies or excesses which may affect grazing animals, it should be borne in mind that the grazing animal is the focal point in a complex ecological system in which a variety of factors have an influence on the supply of minerals which eventually become available to the grazing ruminant. Factors related to the soil such as the hydrogen ion concentration of the soil solution, the chemical interaction between minerals in the parent rock and in the soil, the physical structure and the soil microflora all have a bearing on the amount and availability of minerals. Climatological factors such as the level and seasonal variation of the rainfall and the diurnal and annual variation in temperature, botanical factors such as differences between plant species in habitat, in root system and in mineral requirements, are all in some way or another reflected in the mineral status of the pasture and the grazing animal.

The effect of some of these factors on the trace element content of natural pastures has been reflected in the results of investigations directed from Stellenbosch over the past fifteen years. In these studies of varying scope, surveys of the trace element content of natural pastures were made in the Humansdorp district,[11, 16] in the Little Karroo,[17] over a wide area of the south-western Cape,[17] in the northwestern Cape,[18] in the Swartland,[19] on the west coast,[19, 20] in the district of Hofmeyr,[21] in the Stutterheim district,[22] at Glen in the Orange Free State,[23] on a farm in the Standerton district,[24] at Vaalharts,[25] on a farm in the area known as the Ghaap Plateau[26] and in South West Africa[27, 28].

The satisfactory sampling of natural pasture is always a problem. In these studies, sampling was done by hand and a deliberate attempt was made to sample edible species and edible parts of plants. Chemical analyses and, recently, spectrochemical analyses were made of samples of individual species as well as composite samples. Where possible samples were collected in different seasons.

1. *The effect of soil type and pH on the trace element content of pasture grasses*

The enzootic character of mineral deficiencies and excesses is reflected in the well-founded trust that farmers have in the beneficial effects of a "change of pasture." Samples of banded black wool obtained from single farms in the Western Cape coastal area are practical proof of the variation in copper supply to which sheep on one farm can be subjected over the year.

It is generally accepted that soils differ considerably in their ability to sustain a satisfactory mineral status in pasture plants and grazing animals. The soil characteristics which are mainly responsible for these differences are variable mineral content of parent rock and differences in hydrogen ion concentration of the soil solution, which is the chief determinant of the availability of minerals to plant roots. Nevertheless, in considering the influence of soil type on the trace element content of the pasture growing on that soil, it should be borne in mind that plant species may differ in their ability to accumulate trace elements and also that pastures on different soils may show considerable variation in botanical composition.

In Table 1 the trace element concentrations in natural grass pastures on different soil types are shown.

TABLE 1.—THE EFFECT OF LOCALITY, SOIL TYPE AND pH ON THE TRACE ELEMENT CONTENT OF GRASS PASTURES

Locality and Soil type	n	pH	Trace elements in pasture dry matter				
			Fe mcg/gm	Mn mcg/gm	Cu mcg/gm	Co mcg/gm	Mo mcg/gm
HUMANSDORP (mixed grasses)[11]							
Table Mountain Sandstone	38	5.7±0.20*	282±137*	114±46	9.4±4.4	0.06±0.04	0.29±0.09
Bokkeveld Shales	22	6.1±0.30	348±151	141±51	10.0±4.2	0.20±0.07	0.49±0.17
Dune Sand	5	7.6±0.40	123	25	7.6	0.10	1.01
HUMANSDORP (*Themeda triandra*)[16]							
Table Mountain Sandstone	24	5.5—5.9†	730±601†	113±60	9.7±1.6	0.15±0.10	0.22±0.03
Bokkeveld Shales	13	5.9—6.4	737±355	178±67	9.7±1.9	0.21±0.12	0.23±0.05
Enon Conglomerates	6	4.5—6.8	735±265	144±51	11.0±1.3	0.41±0.11	0.25±0.06
Dune Sand	5	7.6—8.1	296± 84	62±10	7.8±1.7	0.10±0.04	0.52±0.31

* Standard deviation of the sample.
† Range.

In the first survey presented in Table 1, composite grass samples in which *Themeda triandra* predominated, were analysed. From the second survey only samples of *Themeda triandra* were included in the results presented. Three of the soil types differentiated in the survey, viz. soils derived from Table Mountain Sandstone (TMS), Bokkeveld Shales (BVS), and Enon Conglomerates (EC) showed pH values in the acid region of the scale. In the fourth, Dune Sand (DS), the pH of the soil solution was alkaline.

A striking feature of the data presented in Table 1 is that samples collected on DS showed lower concentrations of iron, manganese, copper and cobalt, but higher concentrations of molybdenum than those derived from the other soil types. This is in complete agreement with the generally accepted dictum that the availability of molybdenum is higher in alkaline soil solution, while that of most other trace elements is lower.[29, 30]

Of the samples collected on acid soils those from BVS and EC show higher trace element concentrations than samples collected on soils of TMS origin. A very striking and nutritionally very important feature is the lower cobalt concentration in samples from TMS areas compared to those from BVS and EC.

The soil is such a complex medium that methods of chemical analysis which aim at the prediction of mineral uptake by plants are largely empirical. In most of these methods attempts are made to imitate the dissolving power of plant roots. With the possible exception of cobalt, the successful application of these methods is largely incidental.

In view of the striking difference in cobalt content of pastures on the two main soil types in Humansdorp, Van der Merwe[31] determined the citric acid soluble cobalt (1% citric acid in aqueous solution) of a number of soil samples taken when the pasture samples were collected. The "available" cobalt content of samples of three soil types is presented in Table 2.

The difference in citric acid soluble cobalt between samples of TMS and BVS soils, respectively, was found to be statistically highly significant ($P = 0.01$). Evidently the cobalt content of the pastures is related to the citric acid soluble content of the soil. A further investigation showed that the BVS samples had a significantly higher clay content than the TMS soils. Similar results were obtained in Sweden,[32] where it was shown that hay from a sandy soil contained only 0.05 mcg Co/g DM compared to 0.08 mcg/g in hay from a more loamy soil. In Holland [33] samples of sandy soils showed a significantly lower acetic acid soluble cobalt content than samples of clay soils.

2. *Species differences in trace element concentration*

Many examples are known of plant species which differ in their ability to obtain minerals

from the soil. In most instances this inference is drawn from sampling results obtained in broad surveys, where variation due to soil type inevitably contributed to the variation in mineral content of species. Results of critical comparisons with standardised or properly randomised soil conditions are difficult to obtain. In Holland the mineral content of grasses, clovers and herbs growing in the same soil was investigated by Bruggink,[34] while Gladstones [35] in Australia compared different strains of subterranean clover and lupins with ryegrass and oats in respect of manganese, copper, cobalt and molybdenum content. In Gladstones's study, clovers and lupin species showed a significantly higher copper content than grass and oats growing in the same soil, while *Lupinus albus* had a considerably higher manganese content compared with the other lupin species. Brown and De Wet[36] have recently demonstrated species differences in selenium content of shrubs in the natural Karroo pastures.

Brief extracts from a few of our studies are presented in Table 3.

TABLE 2—THE AVERAGE COBALT CONTENT OF PASTURES IN RELATION TO THE AVERAGE CITRIC ACID SOLUBLE COBALT CONTENT OF SOIL SAMPLES (Both in microgram per gram dry matter)

Soil Type	Pasture	n	Cobalt in soil	Cobalt in pasture
Table Mountain Sandstone	Natural pasture	38	0.18 ± 0.41*	0.06 ± 0.04
Table Mountain Sandstone	Cultivated pasture	5	0.07	0.04
Bokkeveld Shales	Natural pasture	22	2.17 ± 1.64	0.20 ± 0.07
Bokkeveld Shales	Cultivated pasture	2	1.90	0.19
Dune Sands	Cultivated pasture	5	0.19	0.10

* Standard deviation of the sample.

TABLE 3.—THE TRACE ELEMENT CONTENT OF DIFFERENT PASTURE SPECIES (MOISTURE-FREE BASIS)

Locality and species	n	Fe mcg/gm	Mn mcg/gm	Cu mcg/gm	Co mcg/gm	Mo mcg/gm
CALVINIA[18]						
Shrub species						
Eberlanzia	10	266 ± 64*	395 ± 94	8.4 ± 1.0	0.35 ± 0.06	0.26 ± 0.04
Eriacephalus	18	272 ± 30	65 ± 10	10.7 ± 0.7	0.26 ± 0.03	0.39 ± 0.06
Euryops	4	211 ± 44	291 ± 8	11.3 ± 2.6	1.68 ± 0.18	0.76 ± 0.15
Osteospermum	4	344 ± 99	91 ± 15	9.9 ± 1.8	0.25 ± 0.06	1.33 ± 0.49
Pentzia	14	207 ± 31	40 ± 4	12.3 ± 0.9	0.21 ± 0.02	0.63 ± 0.16
Pteronia	14	183 ± 31	43 ± 7	11.6 ± 0.7	0.23 ± 0.03	0.42 ± 0.07
Salsola	6	487 ± 182	100 ± 18	8.3 ± 0.7	0.29 ± 0.07	0.36 ± 0.05
Tetragonia	6	294 ± 39	172 ± 10	10.7 ± 1.3	0.32 ± 0.04	0.74 ± 0.26
HOFMEYR[21]						
Shrubs, single species						
Pentzia globosa	5	1300 ± 131	119 ± 23	16.8 ± 0.4	0.66 ± 0.09	0.61 ± 0.21
Helichrysum	5	3107 ± 193	234 ± 17	16.5 ± 1.2	0.66 ± 0.30	0.61 ± 0.11
Walafrida saxatilus	5	1117 ± 158	116 ± 14	11.3 ± 0.6	0.36 ± 0.11	0.50 ± 0.11
Grasses, single species						
Danthonia disticha	5	619 ± 125	57 ± 10	5.4 ± 0.6	0.15 ± 0.04	0.20 ± 0.02
Eragrostis chloromelas	5	921 ± 112	56 ± 5	6.4 ± 0.5	0.31 ± 0.08	0.25 ± 0.05
Aristida diffusa	5	678 ± 97	53 ± 6	4.3 ± 0.7	0.54 ± 0.40	0.22 ± 0.03
GHAAP PLATEAU[26]						
Shrub						
Tetragonia minor	6	179 ± 6	106 ± 32	11.3 ± 0.6	0.08 ± 0.02	—
Grass						
Themeda triandra	9	332 ± 92	135 ± 39	3.9 ± 0.2	0.08 ± 0.02	

* Standard error.

Although the samples are grouped according to the relatively limited locality in which they were collected, it should be borne in mind that soil differences, and soil preferences of certain species, may contribute to the variation. Nevertheless, the broad difference in trace element content between shrub species on the one hand and grasses on the other is particularly noticeable. Within these broad classes, species differences are discernible, particularly between shrubs.

Differences in root system and in depth of root penetration offer a possible explanation for differences in trace element content of various species. In a number of these studies the interesting observation was made that grass growing in close proximity to or under bushes contains more trace elements than those situated further away. Leaves and other debris from the deeper rooted bushes apparently augment the supply of trace elements in the surface soil layer from which the shallow rooted grass draws its nutrients.

One of the practical implications of these species differences is that grazing animals are able to satisfy their trace mineral needs by the process of selective grazing. In Fryer's[27] recent studies in the northern district of Grootfontein in South West Africa, a very low copper content was noted in the grasses, which are considered to be the staple or only diet of grazing cattle in this area. Copper supplementation of the grazing by means of a copper containing lick elicited no response in these animals, however. Further investigation of the copper content of liver samples indicated a normal copper status of unsupplemented animals. The only reasonable explanation derived from the fact that leaf samples of the shrub, *Tarchonanthus camphoratus*, showed copper levels of four to fifteen times higher than those of the grass samples collected in the same camps.

Another implication of species and soil variation in trace element content of pastures is that the farmer may, for very good reasons which sometimes relate to rehabilitation and improvement of the veld, make it impossible for his animals to select a diet balanced in respect of minerals. As farm subdivisions become smaller, opportunities for diet selection are reduced, particularly if subdivisions are made, as is often the case, according to soil and veld type.

3. *The effects of stage of growth and season on the trace element content of different pasture species*

The practical experiences of farmers indicate seasonal differences in the trace element supply of animals grazing on natural pastures. In Table 4 the trace element concentrations of pasture samples, collected in the growing and in dry seasons respectively, are presented.

For reference purposes the concentrations of crude protein and phosphorus of the samples, analysed at the green and dry stages respectively, are included. It is generally accepted that the protein and phosphorus contents of pasture plants, particularly of the grass family, are markedly reduced at plant maturity and in the dry season.

In contrast to the consistent pattern followed by both protein and phosphorus, the variation in trace element content shows no obvious trend, with the possible exception of the copper concentration which, it is interesting to note, follows a contradictory seasonal pattern in shrub and grass samples respectively. Shrubs show a higher copper concentration in samples collected in the dry season while grass samples show exactly the opposite. Farmers in the copper deficient coastal areas of the Western Cape Province often record the experience that a good rainy season is a "bad" season as far as the manifestation of copper deficiency symptoms is concerned, and that in this area of winter rainfall, summer dropped lambs are less likely to suffer from copper deficiency. A possible explanation for this phenomenon is provided by the data in Tables 3 and 4. In the rainy season grazing animals tend to concentrate on grass and shallow-rooted voluntary annuals, while in the dry summer they are forced to make more extensive use of the shrub species, which show a much higher copper concentration in samples of the edible parts.

Trace element status of the South African veld

The all-important question is: "To what extent do natural South African pastures supply the trace elements needed by grazing animals?" An accurate delimitation of areas in which pastures show deviations in trace element content would be of tremendous assistance to stock farmers. In a country such as South Africa this

TABLE 4 THE EFFECT OF GROWTH STAGE AND SEASON ON THE COMPOSITION AND TRACE ELEMENT CONTENT OF DIFFERENT PASTURE SAMPLES (MOISTURE-FREE BASIS)

Locality, species and stage of growth	n	Crude Protein g/100 g	P g/100 g	Fe mcg/g	Mn mcg/g	Cu mcg/g	Co mcg/g	Mo mcg/g
Bush and Shrubs								
CALVINIA[16]								
Green	52	11.3	0.19	278	104	9.4	0.40	0.5
Dry	52	6.0	0.11	215	76	11.0	0.30	0.5
GHAAP PLATEAU[26]								
Green	4	14.4	0.13	174	74	8.4	0.03	—
Dry	4	10.1	0.08	332	86	8.5	0.08	—
OUDTSHOORN–UNIONDALE[17]								
Green	19	7.3	0.11	507	79	9.1	0.27	0.24
Dry	19	5.4	0.06	1447	97	15.6	0.58	0.29
Grass								
GHAAP PLATEAU[26]								
Green	8	8.6	0.07	480	103	6.6	0.08	—
Dry	8	4.6	0.03	418	140	4.3	0.16	—
STANDERTON[24]								
Green	10	7.3	0.13	156	100	6.7	0.10	0.10
Dry	10	2.8	0.03	326	118	2.7	0.20	0.30
SWARTLAND[19]								
Green	19	9.9	0.13	568	77	7.9	0.30	0.30
Dry	19	5.2	0.08	933	56	5.2	0.20	0.40
WEST COAST SAND[19]								
Green	15	9.4	0.21	414	42	4.8	0.10	0.30
Dry	15	5.4	0.08	594	34	4.2	0.10	0.60

is an almost impossible task at the present stage of development. Even if such a massive survey were economically and physically feasible, the sensible interpretation of such results would remain a hazardous undertaking. There are so many interactions between trace elements and between these and other nutrients, that it is extremely difficult to decide on the basis of pasture analysis whether a particular pasture is able to maintain a satisfactory mineral status in the animal. In Australia, Dick[37] came to the conclusion that the minimum copper requirement of sheep can vary between 1 mcg Cu/g pasture DM and 8–10 mcg/g DM depending, amongst others, on the molybdenum and inorganic sulphate contents of the dry matter. In his studies in the Humansdorp district, Van der Merwe[11] supplied additional copper to grazing sheep on the assumption that the 8 mcg Cu/g DM of the pasture might be marginal. No positive response was obtained and subsequent analyses of the livers of supplemented and control animals showed dangerously high copper levels in the livers of supplemented sheep and normal values in controls. In this particular instance the molybdenum content of the pastures was very low. In the coastal areas of the western Cape, on the other hand, it has proved difficult to raise the low liver copper status of sheep grazing on pastures containing on the average 5–8 mcg Cu/g DM, even with fairly high levels of copper supplementation.

A rational interpretation of the results of pasture analyses is only possible if reliable standards of requirements are available. The reliability of presently accepted standards is unfortunately not above question. For what they are worth, the standards for cattle and sheep, suggested recently by Beeson[38] and by the authoritative British Technical Committee on the Requirements of Farm Livestock[39] are presented in summarised form in Table 5.

TABLE 5 SUGGESTED REQUIREMENTS AND TOXIC LIMITS OF TRACE ELEMENTS FOR CATTLE AND SHEEP, EXPRESSED AS MICROGRAM PER GRAM DM OF THE RATION OR PASTURE (After Beeson and Technical Committee of the British Agricultural Research Council)

Trace element	Minimum requirement		Toxic limit	
	Beeson	ARC	Beeson	ARC
Fe	40	30	2400	—
Mn	20	40	—	—
Cu Cattle	10	10	115	—
Cu Sheep	5	5	12	—
Co	0.1	0.1	30	—
Zn	50	50	900	—
I	0.1	0.1	—	—
Mo	1.0	?	5	3
Se	0.1	?	8	?
F	—	?	—	30—50

In the light of present knowledge concerning requirements of animals and nutrient interactions, these suggested standards can be nothing more than guides, and the analysis of a pasture sample for trace elements nothing more than a starting point or first step in the investigation of the mineral status of pastures. In the absence of clearly recognizable symptoms of deficiency or excess, further information should be obtained from analyses of tissues and organs of a sufficient number of animals representative of those on a particular farm or given area. Armed with information on the trace element contents of pastures and animal tissues, diagnostic dosing trials can be laid down in order to test the response of grazing animals to supplementation of suspected deficiencies. If the free choice system of mineral feeding which is now being exploited commercially in South Africa should prove an unqualified success, the rather laborious procedure suggested above will, of course, become obsolete.

Surveys of the trace element status of the natural pastures in South Africa, some of which have been augmented by tissue analyses and diagnostic dosing experiments, have shown that pastures in the western Cape coastal area are generally deficient in copper and cobalt and that the manganese status is low enough to warrant further investigation, although very few, if any, instances of manganese deficiency in animals have been verified. On the acid, leached, sandy soils of TMS origin on the foothills of the western Cape mountains and in the Humansdorp district, the cobalt status of the pastures is too low.

In a comprehensive survey of the nutrient and mineral status of nearly 4,000 pasture samples collected over the greater part of South Africa, Truter and Louw[40] of Onderstepoort investigated the copper concentration of the samples. They interpreted the results on the assumption that a concentration of less than 3 mcg Cu/g DM is too low, 3–5 mcg/g DM marginal and more than 5 mcg/g sufficient. On this basis 59% of the samples analysed contained "sufficient" copper, 31% were marginal and only 10% contained less than 3 mcg/g DM. Restricted surveys made by us in the northwestern Cape districts of Calvinia and Barkley West, in the Karroo district of Hofmeyr, in Sutterheim, in the Standerton district and in two localities in South West Africa showed no deficiencies of the trace elements investigated, chiefly iron, copper, cobalt, manganese and molybdenum.

Most of the past studies can be criticised for the fact that not all the minerals occurring in traces in plants were included. In some cases this was due to lack of chemical methods suitable for the routine screening of large numbers of samples. As improved facilities for spectrochemical analysis of samples become available, this can be overcome. Very little is known, for instance, about the zinc content of South African pastures. Recent work in Sweden,[41] in British Guiana[42] and in Holland[43, 44] indicated that grazing cattle may suffer from zinc deficiency. Oelschläger and Schwerdtfeger[45] determined Zn, Ni, Cr, B, Al and I in pasture samples collected in South West Africa, and in Fryer's[27] recent study the zinc content of pasture samples from the same region was determined spectro-

chemically at Stellenbosch. In both investigations zinc concentrations as low as 5 mcg/g DM were obtained in the dry season. On the other hand, some of the samples collected by Fryer in the growing season contained as much as 44 mcg/g DM.

In view of the complex factors which have a bearing on not only the trace element content of natural pastures but also on the requirements of animals under different sets of circumstances, it is evident that much more information is required before the diversity of natural pastures in the Republic can be "mapped" realistically on the basis of trace element status. It is to be expected that further intensification of farming systems, which inevitably leads to further subdivisioning, will make it ever more difficult for grazing animals to select a nutritionally adequate diet. An increase in the occurrence of metabolic disturbances can be expected. In investigating such disturbances a co-ordinated effort, including investigations of the soil, the pasture and the animal, is necessary. Diagnosis of trace element deficiencies or imbalances in the field has much in common with modern detective work, where a team of specialists in different fields combine their efforts in a series of routine operations. But even then it remains the responsibility of the animal scientist and the veterinarian to integrate and interpret results and, in view of the complexity of factors involved, the training of the individual in these fields should have a very broad base including at least some knowledge of soil science and botany.

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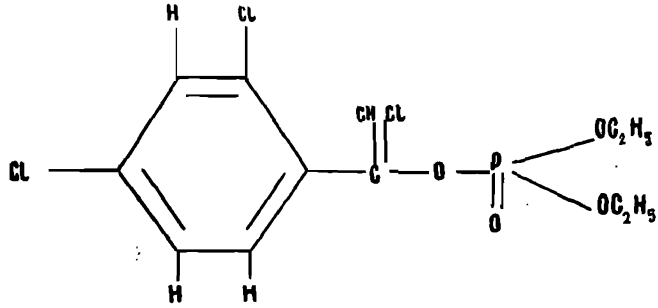

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MECHANISMS OF BILIARY SECRETION IN THE MERINO SHEEP

1. Daily Excretion Patterns of some Components of Bile

J. M. M. BROWN*

SUMMARY

The biliary excretion of water, bile acid salts, bilirubin, copper, iron, coproporphyrin and phylloerythrin has been studied in six sheep. Figures are given for the concentrations in bile of the solid substances mentioned and their 24-hourly excretion rates under various experimental conditions. The importance of the enterohepatic circulation of bile acid salts and the secretin mechanism in relation to bile secretion by the liver cells is discussed.

Copper and iron appear to be excreted by a restricted filtration mechanism, whereas bile acid salts, bilirubin, coproporphyrin and phylloerythrin appear to be actively secreted by the liver cells. Some factors governing the filtration or secretion of these substances are discussed.

INTRODUCTION

The work reported in this paper formed part of the general research programme into the pathogenesis of the ovine disease known locally as "geeldikkop". This disease is one in which there is severe photosensitivity and icterus, the latter being best classed as an intrahepatic cholestasis.[1] Most, if not all, of the constituents of bile appear to be returned to the blood circulation of affected animals at the height of the disease, without there being any obvious mechanical obstruction of the biliary tree.[1, 2, 3] Dyes like bromsulphalein, normally excreted via the bile, also fail to reach the biliary tract at this time, and a biochemical lesion altering the permeability of the hepatic cell wall to various biliary constituents has been postulated as being the essential disturbance in the disease.[2, 3, 4, 5] This work has entailed a study of the mechanisms by which some of the constituents of bile are excreted or secreted by the liver. This paper reports the twenty-four-hourly excretion patterns of some of these compounds.

The mechanism of bile secretion in humans, dogs and smaller laboratory animals has been extensively studied and is also well documented in literature pertaining to general physiology. Similarly numerous studies have been made on the composition of the bile of these species, figures for which are readily accessible. The position is quite different as far as the sheep is concerned. Very little of a comprehensive nature is to be found in the available literature regarding the composition of sheep bile, or the differences in composition between hepatic and gall-bladder bile, or the rates of excretion of biliary components. Most of the standard works on veterinary physiology contain discussions on biliary flow, the functions of the extrahepatic biliary system, and the regulation of bile secretion in ruminant animals. Where sheep are referred to specifically in such discussions one finds that much of the information has been extrapolated from studies on other species. In many instances information is given simply for "sheep" or "lambs", no cognisance having been taken of breed, sex, age or nutritional state. Many figures that are available for the composition of sheep bile are traceable through quite a few textbooks to very early studies. The relevant values are often expressed in a variety of different ways, which can lead to confusion. In many instances no indication is given of whether hepatic or bladder bile was used in the studies concerned.

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The odd pieces of reliable information relevant to the present discussion which have been found in a search through the literature are referred to in the appropriate places in this text.

Materials and Methods

(*a*) *Experimental Animals*: The sheep used in these studies were six adult (full-mouthed) merino wethers weighing between 51 and 67 lbs. after shearing. Cannulae were introduced into the common bile duct proximal to the junction with the pancreatic duct, and brought to the exterior through a stab wound in the abdominal wall, as described previously.[6] The cystic duct was ligated at the gall-bladder end, isolating this structure completely. The bile collected was therefore hepatic bile only. All surgery was done with the animals under chloral hydrate anaesthesia. Bile was collected in the form of hourly samples during the day in the manner described earlier,[6] collections commencing once the animals had recovered from the anaesthesia. Overnight bile samples were treated as single bulk samples, the time involved in the collection being noted for use in obtaining the average hourly excretion of the components concerned over this period. A small amount of medicinal paraffin was introduced into the collecting bottle at the commencement of each overnight period, to exclude air from this sample. Sixteen to twenty samples of bile were taken from each experimental animal and all analyses were performed and completed as soon as possible after collection of each sample.

The sheep were fed on fresh green lucerne, crushed maize and water *ad libitum*, for about three weeks prior to insertion of the biliary cannulae, and for the rest of the experimental period thereafter. The operation for insertion of the cannulae was immediately preceded by a twenty-four-hour starvation period.

(*b*) *Analytical Methods*: All photometric measurements were made either in a Unicam S.P. 500 spectrophotometer, or in an Evans Electroselenium (E.E.L.) portable colorimeter.

Bilirubin was determined by the method of Malloy and Evelyn[7] as applied to bile by Brown and co-workers.[8] Bile acids were determined according to Irvin, Johnston and Kopala[9], using the modification suggested by Doubillet[10] for extracting the acids from bile. Total bile acids only were determined and values are expressed in terms of cholic acid which was used for preparation of standard solutions.

Copper was estimated by an oxalyldihydrazide method of Brown[11] and iron by the method of Marrack[12], both estimations being performed on neutralized sulphuric acid : nitric acid digests.[11]

Biliary phylloerythrin and coproporphyrin were estimated as proposed by Heikel and co-workers.[13]

All reagents used were "Analytical Reagent" grade.

Results

(*a*) *General*: All results obtained were calculated to give excretion or secretion of the substance concerned in ml., mg. or mcg. per 24 hours, as the case may be. These data were then processed in two ways. In the first instance the average 24-hourly excretion of each bile component was calculated for each individual sheep. These results are presented in Table 1. Secondly, all the figures obtained from all the sheep for each bile component were added and averaged. The figures so obtained represent the mean 24-hour excretion of the particular component for the group of six sheep of approximately equal ages and weights, and on approximately the same food consumption level. These results appear in Table 2.

(*b*) *Hepatic Bile Flow*: The experimental animals fall into two groups as regards the pattern of hepatic bile flow following the operation for insertion of the bile duct cannulae. The first group which includes sheep A, C, D and F are animals which commenced eating again within 24 hours of the operation, and ate freely for the rest of the experimental period. Once their appetite appeared to be regained, rumen motility was found to be normal. In all these animals the hourly secretion of bile fell off rapidly during the night after the operation, remained low during the following day, and by the second day after operation had risen once more to reach the values found immediately after insertion of the biliary cannulae. Once this had occurred, the hourly secretion of bile remained fairly constant at these new levels.

Sheep B and E constitute the second group of animals. These sheep scarcely ate at all during the post-operation experimental period and de-

TABLE 1 MEAN 24-HOURLY EXCRETION OF VARIOUS BILE COMPONENTS IN INDIVIDUAL SHEEP

Sheep No. / Determination	A	B	C	D	E	F
Bile Volume (ml/24 hrs)	163.5 (n=21)	224.4 (n=16)	283.7 (n=14)	512.6 (n=16)	138.2 (n=15)	429.7 (n=16)
Copper (mcg/24 hrs)	62.4 (n=8)	225.5 (n=14)	127.0 (n=10)	128.6 (n=15)	78.6 (n=8)	122.4 (n=16)
Iron (mcg/24 hrs)	78.2 (n=8)	114.0 (n=13)	154.6 (n=10)	221.9 (n=15)	91.6 (n=8)	196.3 (n=16)
Bilirubin (mg/24 hrs)	18.6 (n=20)	34.3 (n=16)	60.9 (n=14)	56.0 (n=16)	74.7 (n=15)	49.7 (n=16)
Bile Acids (mg/24 hrs)	533.8 (n=20)	870.4 (n=16)	967.7 (n=14)	2241.0 (n=16)	1690.2 (n=15)	1524.0 (n=16)
Coproporphyrin (mcg/24 hrs)	31.1 (n=21)	34.1 (n=16)	55.7 (n=12)	208.8 (n=16)	47.3 (n=15)	108.7 (n=16)
Phylloerythrin (mcg/24 hrs)	343.9 (n=21)	90.2 (n=16)	1549.6 (n=12)	1644.2 (n=16)	329.5 (n=15)	354.5 (n=16)

TABLE 2 MEAN AND RANGE OF THE 24-HOURLY EXCRETION OF VARIOUS BILE COMPONENTS IN THE GROUP OF 6 SHEEP

Determination	Mean Value of all Figures	Range
*Bile Volume (ml/24 hrs)	284.9 (n=98)	28.0—768.0
Copper (mcg/24 hrs)	133.0 (n=71)	12.9—1119.6
Iron (mcg/24 hrs)	155.1 (n=70)	4.1—408.0
Bilirubin (mg/24 hrs)	47.3 (n=97)	1.9—160.8
Bile Acids (mg/24 hrs)	1275.7 (n=97)	114.1—11588.4
Coproporphyrin (mcg/24 hrs)	79.8 (n=96)	3.7—400.6
Phylloerythrin (mcg/24 hrs)	668.6 (n=96)	35.3—3545.5

*The figures given here have been compiled from all the figures obtained from all six animals. See the discussion in section (b) immediately below.

veloped gastro-intestinal atony. As in the above animals, bile flow declined during the night and day following the operation, but in these instances the decline was sustained throughout the experimental period. Sheep D and E are typical of the two groups. The pattern of bile flow in these two animals is presented in Figure 1 for comparison. Volumes of bile secreted are given in this figure as ml. per hour, since this is a figure which is often useful in work of this

much lower than they should be, if they are to be applied to clinically normal animals, since they include the low values obtained during the period of post-operation anorexia. A closer approximation of the true value is obtained if the values for hepatic bile flow before the post-operation fall, and those found during the subsequent stable period only are used for calculating the mean figure. For instance, in the case of the values for representative sheep D (drawn graphically in

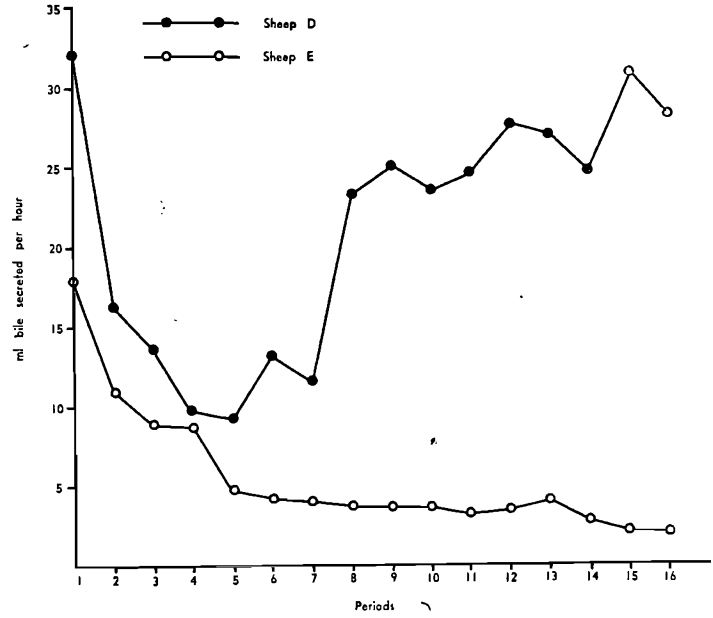

Fig. 1 — Comparison of bile flow in the two groups of sheep as represented by sheep D and E.

nature and one from which the 24-hourly excretion is readily calculated. In animals which start eating again soon after the operation, hepatic bile flow stabilises at from 6 to 32 ml. per hour. The figures which are obtained immediately after insertion of the cannula in this regard, fall within this range.

It is obvious from Figure 1 that hepatic bile flow is markedly influenced by eating, gastro-intestinal motility and absorption (even in the absence of an entero-hepatic circulation of bile salts as is the case in all these animals — more will be said of this particular point in the discussion later). This being the case, the figures given in Tables 1 and 2, for the 24-hourly hepatic bile flow in these six sheep, are obviously

Figure 1), the only values used would be those for period 1 and then periods 8–16. Treating all the values from sheep A, C, D and F in this manner, the figures shown in Table 3 can be obtained.

(c) *Total Bile Acids*: The range found for the concentration of total bile acids in all the samples from the six animals was 92.4 — 2229.8 mg%. When concentration is plotted against sample number (representing the progression of the experiment) the trends shown in Figure 2a were observed. Once again this figure has been constructed from data obtained from sheep D and E which are typical of the two groups mentioned earlier. In the animals which regain their appetite and gastro-intestinal motility, the con-

TABLE 3 CLOSER APPROXIMATION OF THE PROBABLE 24-HOURLY HEPATIC BILE SECRETION IN SHEEP

Sheep No.	Range (ml/24 hrs)	Mean (ml/24 hrs)
A	132—298	212.9 (n=13)
C	264—462	389.4 (n=7)
D	564—768	642.8 (n=10)
F	213—672	517.4 (n=10)
OVERALL RANGE: 132—768		
OVERALL MEAN: 427.4 (n=40)		

centration of bile acids falls rapidly as the bile flow declines, and rises again once "normal" flow becomes restored. The new levels reached during this rise are considerably lower than the initial post-operation values, which are about 5 times as great in the case of sheep D (illustrated), A and C, but were almost 20 times as great in the case of sheep F.

The same trend is seen in the case of sheep E (and B, not shown).

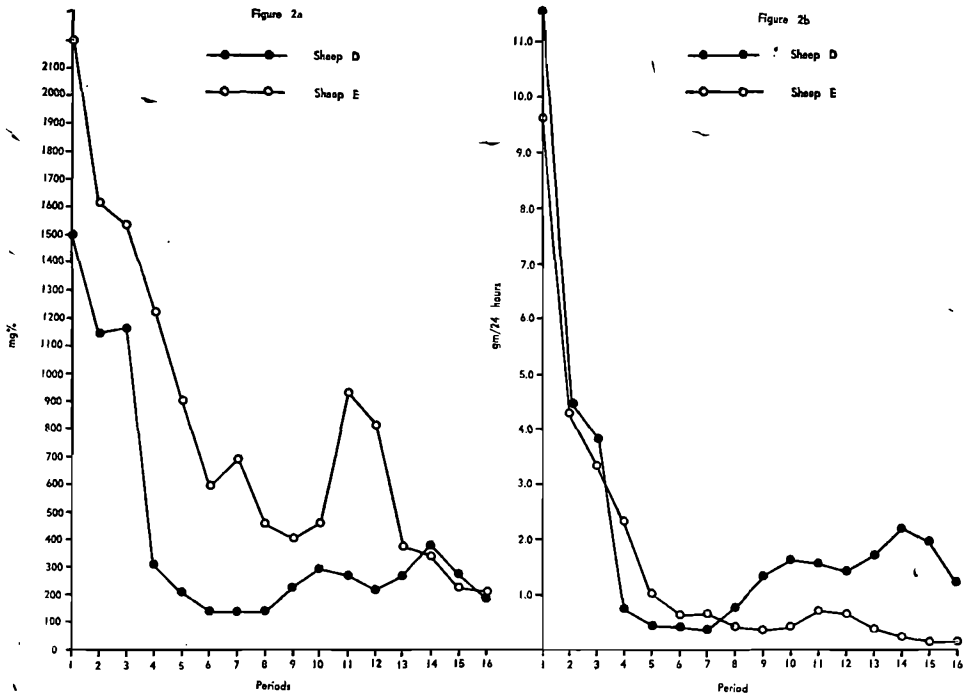

Fig. 2 — Bile Acids

a) Concentration vs. periods

b) 24 hr. excretion of bile acids vs. periods.

When the 24-hourly secretion of these compounds is plotted against time (see Figure 2b), exactly the same type of trend as before is seen in both groups of animals. Although more will be said of this in the discussion later, it is pertinent to note at this stage, that in the absence of an entero-hepatic circulation of bile salts, the relatively stable post-operation levels are far below the levels of secretion at the time of operation. Furthermore, although the concentration of bile salts, and the absolute amounts present in each sample (given as mg per 24 hours) give curves similar to those for bile flow over the experimental period, there does not appear to be much direct relationship between the actual volume of bile secreted in the stable post-operation period and the actual amount of bile acid present in each particular sample.

The values given in Tables 1 and 2 for the 24-hourly secretion of bile acids, are, as in the case of the figures for bile flow, far lower than they should be, because of the rapid fall and/or sustained new very low levels of secretion menioned above. The closest approximation one could get to the true figures would be by taking the immediate post-operation values into consideration only. This gives a 24-hourly secretion range of 3378.6 — 11588.4 mg, with a mean value of 7762.0 mg.

(*d*) *Bilirubin*: The method used for estimation of this compound determines unconjugated bilirubin, bilirubin glucuronides and other water soluble conjugates of bilirubin. It is not a measure of the total pigment concentration.

The data from the two groups of animals can be represented by those obtained from sheep D and E. In Figure 3a, bilirubin concentration has been plotted against time (sample numbers). If this figure is compared with Figure 1, it is obvious that an inverse relationship exists between bilirubin concentration and the volume of hepatic bile secretion. In animals A, C, D and F the initial fall in the volume of biliary secretion is accompanied by a rise in bilirubin concentration. Once the bile flow returns to a stable level again, the bilirubin concentration falls and fluctuates between 4–25 mg%. In animals B and E, where the volume of bile secreted fell progressively as the experiment proceeded, the bilirubin concentration rose to the high levels shown in Figure 3 and continued to fluctuate between 45–100 mg%.

In Figure 3b, the 24-hourly excretion of bilirubin has been plotted against time. The sharp rise just after the operation, seen in both curves shown, was a constant feature in all the experimental animals. It may be due to resorption of haemoglobin from the abdominal cavity and

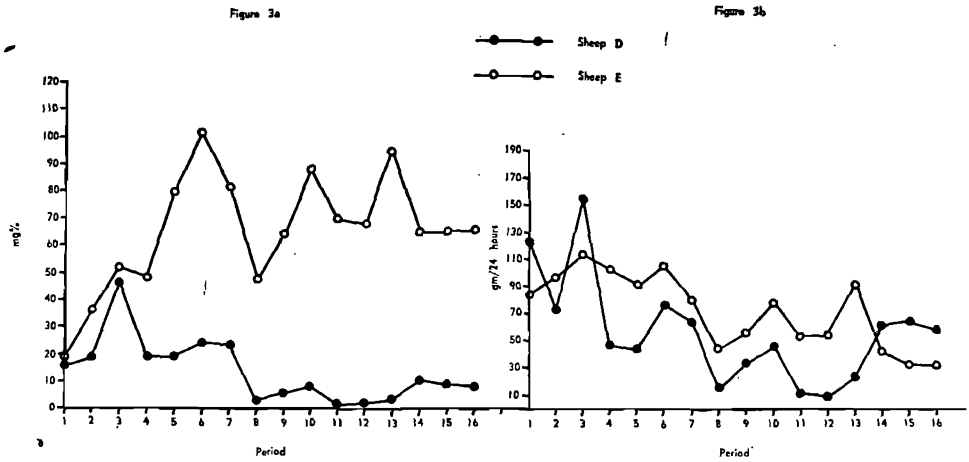

Fig. 3:

a) Concentration vs. periods

b) mg per 24 hour vs. periods.

its subsequent destruction. After this initial rise, the excretion of bilirubin fluctuated between 10–80 mg. per 24 hours in all the sheep except sheep E, where it varied between 35–90 mg. per 24 hours. It is apparent from these studies that bilirubin is secreted at a relatively constant rate in the sheep, irrespective of changes which may take place in the volume of hepatic bile flow.

(*e*) *Copper*: The concentration of this element in the bile samples of sheep D and E and its 24-hourly excretion, are both plotted against time (sample number) in Figures 4a and 4b. An inverse relationship of concentration to hepatic bile volume is seen in the curve for sheep D in Figure 4a. This curve is typical of the data for biliary copper from animals A, C, D and F. Copper excretion becomes stabilised in these animals after some initial fluctuations, at levels of from 10–35 mcg.%.

The animals which failed to regain their appetite after operation, sheep B and E, show a gradual but fluctuating fall-off in copper excretion as biliary secretion declines. The initial high figures for bile copper concentration in both groups of animals may be related to post-operation resorption of blood coagula. The excretion of copper seems to proceed over a relatively constant concentration range (animals A, C, D and F). The curves for the 24-hourly excretion of this element, followed the curves for the volume of hepatic bile flow very nicely in all of these animals. (Figure 4b). The same trend was observed in sheep E, but not in sheep B, where the excretion of copper fluctuated between levels of 50–160 mcg per 24 hours, after some initially high values, falling precipitately at the end of the experiment to 26.4 mcg per 24 hours. This sudden fall-off in excretion coincided with a similar abrupt decline in biliary flow.

It would appear from these data that the biliary excretion of copper in sheep on a given diet takes place at a relatively constant rate and concentration. It appears to be more volume dependent than that for bilirubin.

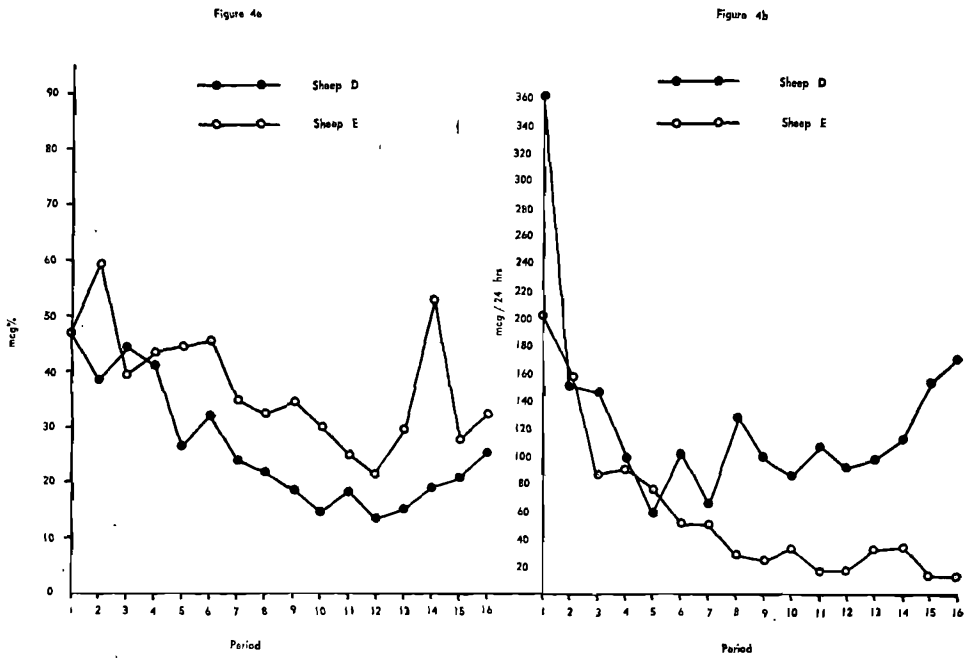

Fig. 4:
Copper; (a) Concentration vs. periods.
(b) mcg per 24 hr. vs. periods.

(*f*) *Iron*: The data from sheep D and E are again representative and are plotted as before, in Figure 5.

In sheep A, C, D and F, the first bile samples after the operation contained high concentrations of iron, which fell off and became settled between 25–55 mcg% as bile flow became more regular. As in the case of copper, the curves for the 24-hourly biliary excretion of iron follow the volume curves almost exactly. Sheep B and E both showed the initial high biliary iron concentrations, which probably follow post-operation resorption of blood coagula. In both animals concentrations rose as volumes fell (Figure 5b) and the 24-hour excretion curves are almost identical to the volume curves. Like copper therefore, iron is excreted via the bile at a relatively constant rate and concentration under "normal" circumstances.

(*g*) *Coproporphyrin*: The relevant data are represented by the curves for sheep D shown in Figures 6a and 6b. Coproporphyrin was excreted at a relatively constant concentration in the bile of all the sheep except sheep E, at levels varying between 0.10–0.60 mcg per ml. In any single animal the fluctuations in concentration between samples seldom exceeded 0.30 mcg per ml, irrespective of the rate of hepatic bile flow. Sheep E, whose coproporphyrin curves are shown in Figures 6a and 6b as well is actually exceptional in that towards the middle of the experiment (while bile flow was declining) a sharp rise in coproporphyrin concentration occurred. This peak apart, the coproporphyrin concentration stayed mainly within the range 0.3–0.5 mcg per ml. The same sharp rise is seen in the curve for the 24-hourly excretion of this porphyrin, which otherwise follows the curve for the volume of hepatic bile secretion. In all the other animals the curves for biliary volume and 24-hourly excretion of coproporphyrin are virtually identical.

(*h*) *Phylloerythrin*: This porphyrin may be considered as an exogenous waste product which is eliminated via the bile, since it is formed during microbial degradation of chlorophyll in the digestive tract. This being the case, the amount present in the bile at any time would depend upon (*a*) the amount of chlorophyll in the diet and the amount of food consumed; (*b*) the activity of the micro-organisms in the gastro-intestinal tract, and (*c*) the motility of the gastro-intestinal tract, since upon this will depend the rate of absorption. On the grounds of these statements, one would expect very different patterns of phylloerythrin excretion in the two groups of sheep. The patterns of excretion are represented by the data from sheep D and E and are shown graphically in Figures 7a and 7b.

In the samples from sheep A, C, D and F, the phylloerythrin concentration is initially low. This is due in all probability to the pre-operation starvation period. The concentration levels start climbing rapidly as "normal" bile flow becomes resumed, which as explained earlier occurs when gastro-intestinal motility is restored and appetite is regained. Once "normal" bile flow is resumed, phylloerythrin concentrations tend to plateau as well. The phylloerythrin content of the bile of these four animals varied between theitlism 0.12–8.69 mcg per ml throughout the experiment.

The curves for the 24-hourly excretion of this pigment in these four sheep, although following the general trend of the curves for hepatic bile flow, are not quite similar in shape (cf. the same curves for coproporphyrin, iron and copper for example).

These data nevertheless lead one to think that phylloerythrin is excreted at a reasonably constant rate and that its excretion depends on the volume of bile flow.

The two sheep B and E which presumably failed to regain their gastro-intestinal motility after the operation are represented by sheep E in Figures 7a and 7b. Phylloerythrin concentration in the bile of these animals rose gradually in the successive samples as the bile volume gradually declined, finally falling precipitately at the end of the experiment. This datum in itself indicates a fairly constant output of phylloerythrin. The curve for the 24-hourly excretion of the pigment is, however, in the case of these two animals, quite different to that for the volume of bile secreted (compare Figures 1 and 7). The shape of this curve leads one to suspect a reasonably constant output of residual phylloerythrin which had been absorbed prior to, during and just after the operation, but it is apparent that its excretion is not as dependent on the volume of bile as one would imagine from the data obtained from the first four sheep. It appears that as an endogenous waste product its elimination must be maintained as far as the liver is able to do so.

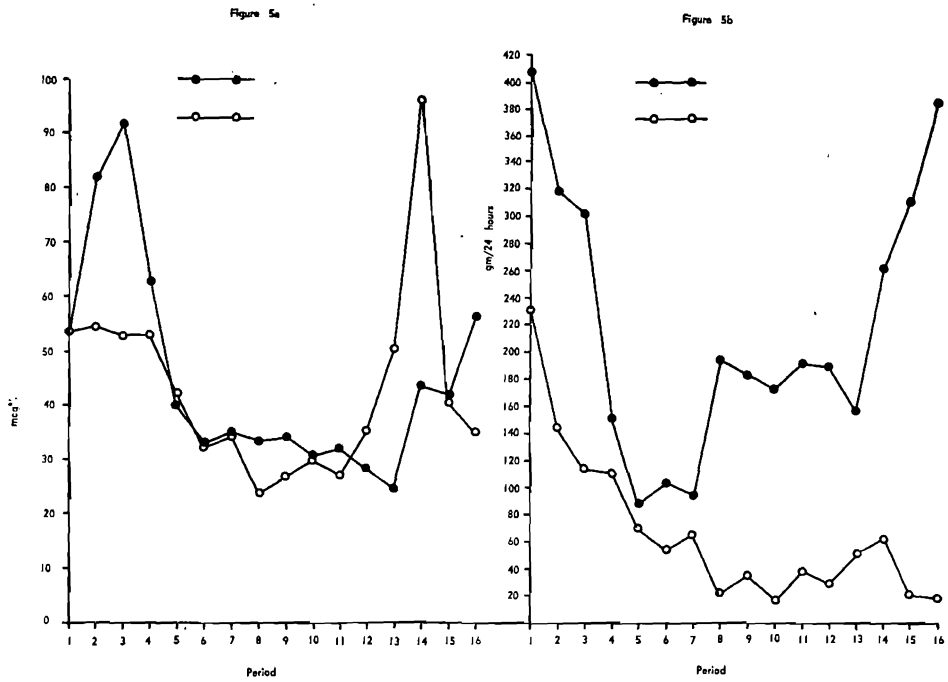

Fig. 5:
Iron: (a) Concentration vs. periods.
(b) mcg per 24 hrs. vs. periods.

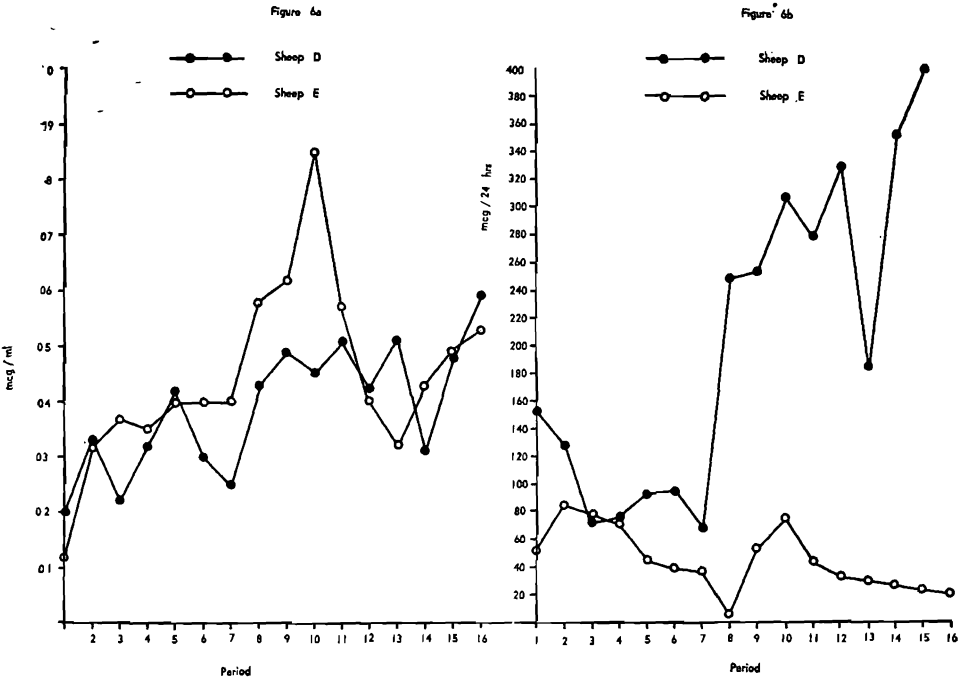

Fig. 6:
Coproporphyrin: (a) Concentration vs. periods.
(b) mcg per 24 hrs. vs. periods.

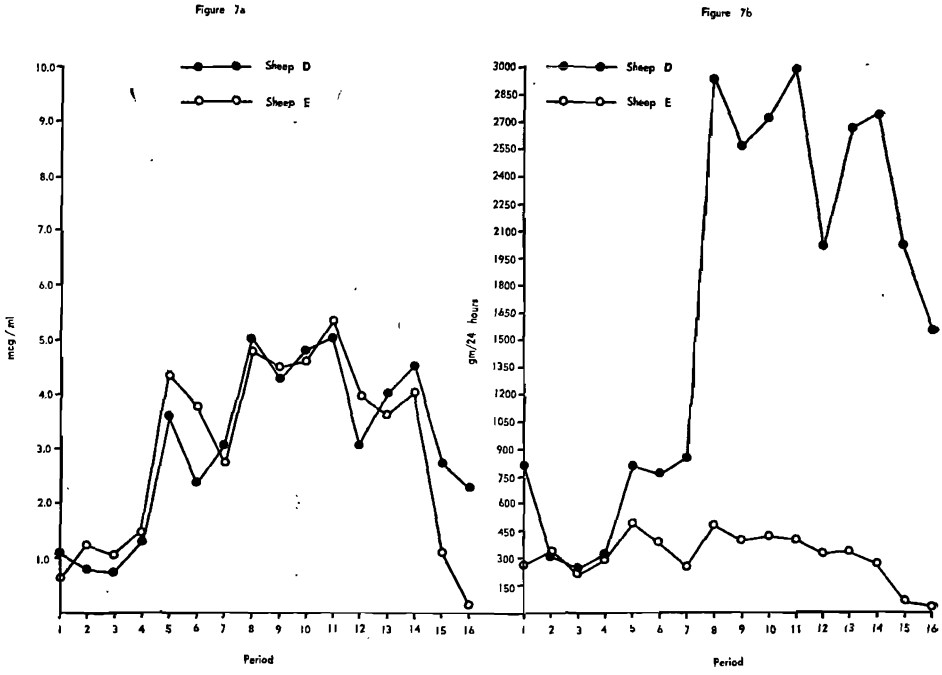

Fig. 7:
Phylloerythrin: (a) Concentration vs. periods
(b) mcg per 24 hrs. vs. periods.

Discussion

It is pertinent to review briefly what is known of hepatic bile flow in the sheep. The secretion of bile by the hepatic cells is a continuous process whether the animal is digesting or not. Although continuous, secretion is not uniform since the rate of secretion can be altered by a number of conditions and factors.[14, 15, 16] The total volume of bile secreted by the liver has not been well established in man or animals. It is dependant on sex, surface area, body weight and the amount lost through biliary fistulae during the course of experiments such as are described here.[17] The precise stimulus for the secretion of bile is not known, but it may be any of the following: (a) a number of observations make it likely that a humoral mechanism is concerned. Bile salts, secretin and other substances absorbed from the intestine act as excitants, such stimuli coming from the seat of most active digestion where bile is naturally required, namely the small intestine.[14, 18]

(*b*) Bile secretion by the liver parenchyma is a function of the rate of blood flow through this organ. The effects of the blood circulation are important but complex, and differ from species to species, particularly with regard to the mechanics of blood flow through the liver.[14,17,18]

Whatever the mechanisms are controlling the secretion of bile in sheep and other ruminants, they are believed to be basically similar to those in other species.[19] Hepatic bile flow is increased by feeding diets rich in protein,[17] by the entry of bile or acid into the duodenum,[14, 20] by vagal stimulation which can more than double the secretion[16], by increased portal blood flow,[16, 17] and by stress, hunger and various emotional factors.[17] The entry of protein-rich and acid material into the duodenum seems to be the most important factor in this respect.[17] Bile flow is decreased on the other hand with fasting,[14] by distention of the colon,[17] portal vein occlusion or increase in hepatic arterial pressure,[17] by stimulation of the splanchnic and

hepatic nerves,[17] by anoxia which has no effect on bile salt production,[17] in nausea and vomiting[17] and during rage, rest or sleep.[17]

The acts of feeding and rumination are said to have no effect on the bile flow of the ruminant, since there is little need in these animals for the sudden outpouring of concentrated bile as occurs for instance in the dog after a meal rich in fat.[14, 19] Bile flow in the sheep also shows no volume response to different foods, and the variations on any one diet exceed those found by earlier work on different diets.[19] Refined carbohydrates and non-metabolizable sugars are without effect on bile flow in man.[17, 20]

Bile secretion is diminished in starvation and rises again sometime after food intake and the commencement of absorption.[18, 19] An even greater reduction in bile flow occurs after emptying of the rumenoreticulum in sheep, but a certain basal level of secretion still always occurs.[19]

The enterohepatic circulation of bile acid salts has always been held as one of the prime humoral mechanisms in maintaining the rate of bile flow in all animals.[16] It appears to be just as important in sheep where it regulates the rate of flow and the composition of bile.[19] Loss of bile acid salts to the exterior reduces bile secretion several fold since this represents an alteration of the physiological stimulus to bile production.[16, 17] If however a bile fistula continues to empty the bile to the exterior for several days to several weeks in human patients, the liver is able to increase its production of bile salts as much as ten-fold, which increases the rate of bile secretion approximately back to normal.[16] This is held as a demonstration that the daily rate of bile salt secretion is actively controlled, although the mechanism of this control is not known.[16] Furthermore it appears to be assumed that in human patients, bile becomes essentially normal when it is allowed to drain from the common bile duct for two to three weeks following cholecystotomies and removal of bile duct obstructions.[21]

Return of fistula bile in sheep to the intestines maintains hepatic bile flow at a high level. Bile secretion by the liver appears to be particularly sensitive to the composition of the bile added to the intestines, and it appears to be possible to regulate the composition of secreted bile by returning bile of varying solid content.[19] By analogy with other species it seems probable that the bile acid salts are the bile components involved in this process.[19] It is thus obvious that estimates of the volume and composition of bile secreted must be based on material collected under conditions where bile is continuously returned to the duodenum. The hepatic flow in the sheep is under such conditions 700–800 ml per 24 hours.[19]

Secretin has a moderate effect on liver secretion effecting as much as an 80% increase in bile production without any increase in bile acid production.[16] Introduction of acid into the duodenum will stimulate bile formation presumably via the secretin mechanism, but injections of secretin preparations do not bring about the same effects.[20] It has been suggested that some other "metabolic products" of the pancreas are responsible for the secretin effects on bile flow.[20] Secretin is known to influence bile formation in the dog and cat even in the absence of an entire gastro-intestinal tract, pancreas and spleen, or after complete denervation of the liver.[17, 15] A well developed secretin mechanism is known to exist in ruminants.[19]

Various figures have been found in the literature relevant to hepatic bile flow, regarding the daily output of bile in the sheep. As mentioned earlier, Lewis[19] cites the figure of 700–800 ml per 24 hours in animals where an enterohepatic circulation of bile acid salts is maintained. Quin,[22] using 2–4 tooth wethers weighing 50–58 lbs. and maintained on a ration of veld hay, green lucerne and crushed yellow maize fed *ad libitum* during the day only, found considerable variations in the daily output of bile by his sheep. His figures ranged from 125–390 ml per 24 hours, while the mean values given by him for individual animals ranged from 220–300 ml per 24 hours. Other figures which I have been able to find are expressed in various different ways. These are given in Table 4.

Taking the specific gravity of ovine liver bile as 1.010 and assuming a mean body weight of 55 lbs., these figures can be related to the previous ones by some simple calculations. The figures given by Dukes[14] and Harvey[23] work out to be 628.5 and 750 ml per 24 hours respectively, which agree closely with those cited by Lewis.[19] On the other hand the data given by Scheunert and Trautmann[18] and Schmidt and Ivy[24] fall within the range 297–396 ml per 24 hours;

TABLE 4 FIGURES, WHICH HAVE BEEN TAKEN FROM THE LITERATURE, FOR THE DAILY BILE SECRETION IN SHEEP

Author(s)	Values cited
Dukes[14]	25.4 g per Kg bodyweight
Harvey[23]	30 ml per Kg bodyweight per day
Scheunert & Trautmann[18]	300–400 g per day
Smith[15]	8–150 g per hour
Schmidt and Ivy[24]	12.1 ml per Kg

figures in the same order as those found by Quin.[22] Smith's[15] lower value falls into this latter range but the value of 150g per hour, means a total of 3,564 ml per 24 hours, which seems quite excessive.

Diurnal variations in bile secretion are a constant feature in man. More bile is excreted during the day than during the night. The diurnal variation is the result of the interaction of many factors, e.g. food intake, especially protein, rest or activity, sleep.[17, 21, 25] Quin[22] found no constant relationship between the day and night yield of bile in his sheep. In general the day yield was in the same order as the night yield and there was no suggestion of a constant diurnal rhythm.

Let us consider now the figures obtained for hepatic bile flow in this study. As pointed out earlier starvation and anorexia and loss of gastro-intestinal motility significantly affect the rate and volume of hepatic bile flow. This is well illustrated by Figure 1. It is also obvious from this figure that there is always a basal rate of bile secretion in the sheep, irrespective of the degree of gastro-intestinal motility or whether the animal is eating or not.

The figures given in Tables 1 and 2 for the 24-hourly excretion of bile in the six animals used are in the same order as those given by Quin,[22] Scheunert and Trautmann[18] and Schmidt and Ivy.[24] For the reasons already mentioned in this study, these figures are obviously far lower than they should be. The same reasons presumably hold for the other work just cited. The figures given in Table 3 are still lower than those cited by Lewis,[19] Dukes[14] and Harvey[23]. These figures, as explained, have been computed from the immediate post-operation period and the period during which bile flow stabilizes in animals which regain their appetite. There is however a most interesting point regarding these figures which constitutes a trap for the unwary The figures obtained for the first samples of bile after operation in all six animals represent bile secretion in a fasting state; that is, a state in which there is decreased rumination, absorption, ruminal motility and portal blood flow, all of which are factors known to decrease hepatic bile secretion. When bile flow increased again to the new stable levels in animals A, C, D and F, these levels never exceeded the first fasting levels by any significant amount. Thus the figures in Table 3 are in fact a truer reflection of hepatic bile flow of sheep in a fasting state than in animals whose normal activities are unrestricted.

It is obvious from the work cited by Lewis[19] and these figures, that the enterohepatic circulation of bile acid salts must be maintained if figures anything like the true 24-hourly hepatic bile secretion are to be obtained, and if the composition of the bile is to remain unaltered. In the experiments reported here, considerable amounts of bile salts were lost to the exterior, and this particular stimulus to hepatic bile secretion was removed. The return of bile flow to fasting levels in animals A, C, D and F is accompanied by a considerably lower level of bile acid secretion than the fasting levels. This represents a hydrocholeresis very similar in nature to that of the secretin effect. It is very likely that in animals like these, maintained on a reasonably high protein diet, and losing bile salts to the exterior, the secretin mechanism is important in raising the flow of bile to fasting levels and maintaining it there together with such factors as increased portal blood flow, which attend increased absorption and gastro-intestinal motility. The "truer" levels of secretion reported by Lewis[19] would then be due to a summation of these effects and the effects of the entero-hepatic bile acid circulation.

As found earlier by Quin,[22] there does not seem to be any constant relationship between the secretion of bile during the day or night. The variation between the patterns of excretion of the different animals and the variations in the patterns of excretion in individuals make it unlikely that any diurnal rhythm of bile secretion really exists in the sheep. The relevant data pertaining to this aspect have been taken together in Table 5. The figures given here have all been calculated back to standard 12-hour periods in order to make comparison easier.

TABLE 5 COMPARISON OF HEPATIC BILE FLOW DURING THE DAY AND NIGHT, IN THE SHEEP USED

Sheep No.	Day Flow (ml/12 hrs)	Night Flow (ml/12 hrs)
A	65.9	85.9
	36.0	24.3
	108.0	14.2
	120.0	29.6
	94.4	139.7
	105.9	149.0
B	306.0	137.5
	81.7	72.4
	92.8	155.1
	69.0	46.9
C	211.0	67.0
	64.8	143.3
	167.3	208.2
D	248.0	119.3
	136.0	290.6
	293.1	332.8
	334.1	339.5
E	98.2	45.3
	42.0	41.4
	36.9	24.9
F	140.0	138.4
	130.8	221.5
	261.7	106.3

The range of 3378.6–11588.4 mg per 24 hour for bile acid secretion mentioned earlier, represents once more the level of these compounds in the bile of fasting sheep. It is known in man and smaller laboratory animals, that during fasting there is a uniformly low excretion of bile acid salts.[26] This level may be lowered further by the ingestion of a carbohydrate rich diet and raised to a maximum by protein rich diets.[26] No figures have been found in the available literature for the 24-hourly biliary output of bile acids in sheep. Humans are known to secrete 3.4–11.5 gm per day[21] and dogs anything from 0.02–1.13g per kg bodyweight per day;[17] a mean figure for dogs of 100 mg per kg per day is also cited.[17] For dogs weighing 55 lbs. (the average weight of the sheep used in this work) the range would thus be 0.5–28.3g per day with a mean value of 2.5g per day. The values obtained for sheep in this work (3.4–11.6g per day) are thus in good agreement with the figures for man and dog. The figures for sheep on an unrestricted diet are probably somewhat higher.

The levels at which bile acids stabilized after the return of bile flow to fasting levels in sheep A, C, D and F represent the basal secretion in the absence of an intrahepatic circulation of these compounds and on a reasonably high protein diet. It is known in man that diversion of bile through a biliary fistula reduces the bile acid content of the bile, due to failure of the enterohepatic circulation. This acts as a stimulus to further bile acid formation by the liver to replace the amount that should be in normal circu-

lation.[17] (On the average bile acids normally make an entire enterohepatic circuit about 10 times before being lost in the faeces or by other routes[16].) If bile is diverted from this circulation the liver, in man at least, is able to form at least ten times the normal amount of bile acid.[17] This increase gradually declines but returns significantly on feeding meat or certain amino acids.[17] It is not known whether this phenomenon occurs as effectively in the sheep as in man. It is obvious from Figure 2 that the ovine liver is at least able to maintain a certain basal level of secretion of bile acids for periods such as the duration of these experiments (3–7 days).

The range of concentrations of bile acids found in all the samples from the six animals was 0.092–2.23g%. This range is similar to that given for liver bile of the dog[14, 18] and human.[16, 17, 20–29]

A few figures have been found in the literature giving the concentration of bile pigment in sheep bile which is variously given as e.g. 0.1 gm%[23] and 107.5 mg%[24]. The other figures found are concentrations of pigments and mucins together and have been disregarded for the purpose of this discussion. Concentrations of the pigment in all the samples from the six animals used in this study ranged from 1.0–103.2 mg%. No figures have been found in the literature for the 24-hourly production of this pigment. The more or less stable range of 10–80 mg per 24 hours found in these six sheep is considerably below that given for human subjects as 0.5–2.1g per day.[17, 21]

Bile formation is influenced by the same factors as urine formation, although it does not respond so readily to the changing needs of the organism, nor does it influence the body fluids as radically as does urinary secretion in spite of the fact that the total amount of biliary substances is considerable.[17] It has been suggested on morphological grounds and on the basis of experiments designed to study the excretion of substances like bromsulphalein and bilirubin that the complex of bile ductules and peribiliary plexuses might in some respects function as a secretory mechanism similar to the renal tabule.[30, 31, 32] The idea is an intriguing one but is still a subject of considerable debate.[33, 34, 35]

The appearance and amount of any substance in the bile, as in the urine, presents three possibilities, notably, (*a*) diffusion or filtration from the bloodstream; (*b*) secretion by the hepatic cell, which may or may not be preceded by extraction of the secreted substance from the blood; and (*c*) re-absorption of the substance or of the water in which it is dissolved, from the biliary passages. By using the classical methods employed in studies on renal function, Cook and coworkers[36] have demonstrated in dogs that two principal mechanisms are in fact concerned in the production of bile, namely filtration and active secretion.

A bile filtration mechanism is suggested by the similarities in the composition of bile and plasma except for the absence of plasma proteins. The osmotic pressure of bile is comparable to that of blood.[36] The list of substances shown to be filtered include water, sodium, potassium, lithium, chloride, urea, creatinine, glucose, cholesterol and inulin.[36, 17] These substances are not materially concentrated in the bile. When the bile and plasma concentrations are compared they approximate unity. As a result the excretory rates at any particular plasma concentration are in general proportional to the rate of bile flow. The substances mentioned are secreted at very low clearance rates which do not differ materially from one another.[36] In general clearance rates are high and are independent of plasma concentrations and with the exception of creatinine the bile plasma concentration ratios were found to be independant of water clearance.[36]

The operation of a hepatic secretory mechanism is suggested by the concentration in bile of such substances as bile acid salts, bile pigments, and administered substances like bromsulphalein, p-amino-hippuric acid and certain antibiotics.[36] In general, these substances occurred in bile at levels many times their plasma concentrations. Their quantitative behaviour differs markedly. A maximum excretory capacity (designated as Lm) has been demonstrated for each substance.[36]

The excretion of iron and copper in the bile of sheep seems to proceed, as suggested by the studies reported here, by a mechanism which involves restricted filtration. Copper excretion stabilised during these experiments at 10–35 mcg% in the different animals, and iron at 25–55 mcg%. Both values are considerably below the plasma levels for either element which are generally in the order of 80–120 mcg%. It

is suggested by the results of these experiments however that when fair amounts of iron and copper are suddenly released in the body (as would occur following destruction and resorption of blood coagula) the level of "filtration" can be raised, and concentrations of either element which approximate the plasma levels can be attained in the bile.

Bilirubin is actively secreted by the liver cells.[36] The clearance of this pigment is significantly correlated with water clearance. Secretion of bilirubin is accompanied either by a secretion of water or by an increase in its rate of filtration.[36] The experiments reported here indicate a relatively constant rate of bilirubin secretion in the sheep irrespective of the volume of hepatic bile flow. Techniques such as those used by Cook and coworkers[36] will have to be used to confirm or refute this point. There is no apparent reason why the sheep should differ from the dog in this respect.

Coproporphyrin appears, from the data presented here, to be secreted and this at a very constant rate, independent of water filtration. Like bilirubin it can be considered as an endogenous waste product. Since like bilirubin it is presumably formed at a constant rate in "normal" animals, one would expect a very finely regulated balance between formation and excretion.

Phylloerythrin is on the other hand a waste product of exogenous origin, which can be formed in the gastro-intestinal tract of the ruminant in far larger amounts than coproporphyrin is formed in its body. The rate of formation and amount formed depend entirely on the chlorophyll content of the diet, the amount of food consumed, the motility of the digestive tract and the viability of its microbial population. The concentrations attained in the bile of the experimental animals used in this work are far above those encountered in the blood of normal sheep, where the concentrations of this porphyrin are usually below the limits of detection by the method used. One may thus infer an active biliary secretion of phylloerythrin, and for the reasons given earlier, one which is not necessarily volume dependent under all circumstances.

Acknowledgement

I wish to thank my professional assistants, Adriana Wagner and Anna Brink, for their patience and considerable assistance with this work. Anyone who has performed hundreds of porphyrin analyses on body fluids by conventional means can appreciate the magnitude of their task in this single instance. My technicians, P. J. de Wet and R. Gray are thanked for their assistance. Professor Richard Clark gave his usual unfailing guidance and helpful criticism.

The Chief, Veterinary Research, Onderstepoort, is thanked for permission to publish this work.

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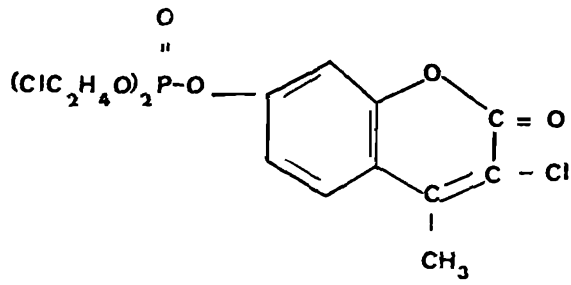
HALOXON



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J. 4790

Jl S. Afr. vet. med. Ass. 38 (4): 383-388 (1967)

THE CHEMICAL PATHOLOGY OF OVINE ICTERIC STATES

2. Effect of Experimental Obstruction of the Common Bile Duct Associated with Simultaneous Kidney Lesions

J. M. M. BROWN*

SUMMARY

The superimposition of acute renal failure on a developing syndrome of common bile duct occlusion accentuates many of the symptoms and disturbances of the latter condition. The intensity of icterus is accentuated. Hypercupraemia appears earlier than it does in uncomplicated biliary obstruction and is due mainly to a marked increase in ceruloplasmin copper. The effects of stress on copper metabolism are mentioned and an opinion expressed as to the possible role of the red cell in this regard. The effects of simple tissue injury on the activity levels of many plasma enzymes are discussed and the chemical pathology which can be expected in acute kidney injury in the sheep is demonstrated.

INTRODUCTION

The work reported in this paper formed part of the general research programme into the pathogenesis of the ovine disease known locally as geeldikkop. It is a disease in which there is severe photosensitivity and icterus, the latter being best classed as an intrahepatic cholestasis.[1] Most, if not all of the constituents of bile, appear to be returned to the blood circulation of affected animals at the height of the disease, without there being any obvious mechanical obstruction of the biliary tree.[1, 2, 3] A biochemical lesion altering the permeability of the hepatic cell wall to various biliary constituents has been postulated as being the essential disturbance in the disease.[2–5] The co-existence of similar lesions in the kidneys is believed to aggravate the condition and accentuate such symptoms as phylloerythrin retention, hyperbilirubinaemia and hypercupraemia.[1, 2, 4, 5] Advanced cases of the disease show marked uraemia which cannot be reconciled with the fairly mild renal pathology.[1, 2] The studies described in this paper were designed to establish which aspects of the chemical pathology of geeldikkop could be ascribed to co-existing cholestasis (induced here by mechanical obstruction to bile flow) and renal lesions and which were germane to the disease itself.

MATERIALS AND METHODS

(*a*) *Experimental Animals*:

Eight adult merino wethers weighing between 50–65 lbs after shearing were used, and designated numbers 19773, 4680, 2759, 19792, 20103, 20134, 20151 and 16551. They were maintained and fed as described in the previous paper of this series.[6] Urine was collected in polythene collecting bottles and faeces in standard collection bags as described before.[6]

Cholestasis was produced by ligation and section of the common bile duct and ligation of the cystic duct as detailed elsewhere.[6] The syndrome of common bile duct occlusion[6] was allowed to develop until it was clinically and biochemically obvious (generally about 3–5 days after operation) and then acute renal failure was produced by oral dosing of a mixture of 30 ml of ethylene glycol mono-methyl ether (methyl cellosolve) in 100 ml of water followed 24 hours later by 30 ml of diethylene dioxide (dioxan) in 100 ml water. The syndrome of common bile duct occlusion

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and acute nephritis generally lasted from 5–7 days before terminating fatally in all the animals concerned.

Sheep 19773 was used as a control in that a sham operation was performed on it. Laparotomy was done as usual under chloral hydrate anaesthesia. The common bile duct was freed from the surrounding pancreas tissue but not ligated, the liver and gallbladder were handled in the same manner as in animals in which the cystic duct was ligated, and the abdominal wound was closed as usual.

Sheep 4680 was a further control in that it was subjected only to acute kidney injury as described.

The remaining six animals, namely sheep 2759, 19792, 20103, 20134, 20151 and 16551, were used to study the effects of combined bile duct occlusion and kidney injury.

(*b*) *Analytical Methods*: These were exactly as set out in the previous paper in this series.[6]

Results

1. Common bile duct occlusion and acute kidney injury

During development of the syndrome of bile duct occlusion (3–5 days post-operatively) the chemical pathology was exactly as described before.[6] The discussion which follows is limited in general to the subsequent course of events and only where of particular interest are data covering the entire experiment given. Base line values or established normal ranges for the various determinations were in general as given in the previous paper.[6]

(*a*) *Haematological Studies*: Red cell counts, total leukocyte counts, packed red cell volume, haemoglobin and red cell fragility were studied. In three out of the six animals (sheep 20134, 20151 and 16551) no red cell dyscrasias were evident throughout the entire period after induction of kidney damage. The remaining three showed a mild decrease in red cell count, packed cell volume and haemoglobin as the experiment proceeded. Red cell fragility increased slowly as described earlier,[6] but never went beyond the established normal limits. Leukocyte counts decreased in all cases by at least half to three-quarters of the values found before administration of the nephrotoxic glycols. At death severe leukopaenia was the rule.

(*b*) *Bile Pigment and Bile Acid Excretion*: Plasma total bilirubin values were generally in the order of 3.4–8.2 mg% before induction of kidney damage, nearly all of the pigment present being bilirubin glucuronide. Small amounts of bilirubin were present as well, as was noted previously.[6] Bilirubinuria and bileaciduria were marked. After administration of the nephrotoxic agents plasma total bilirubin levels climbed sharply, nearly all the pigment present still being the glucuronide, while bilirubinuria and bileaciduria diminished rapidly. Three to four days after administration of the glycols the small amounts of urine passed generally contained no bile pigments or bile acid salts.

Clinical icterus was generally severe at the time of death and the faeces were completely acholic.

(*c*) *Porphyrin Excretion*: The pattern of porphyrin excretion before the inception of the renal changes was as described before.[6] Acute kidney injury was followed by intense photosensitivity and complete absence of porphyrins from the urine. Plasma porphyrin levels were not studied in these cases.

(*d*) *Liver Function Tests*: Thymol turbidity tests were consistently negative and thymol flocculation tests faintly positive during the combined syndrome. Zinc sulphate turbidity tests yielded results within the normal limits, but the colloidal gold flocculation tests gave positive reactions in the terminal stages of the syndrome. Total cholesterol values were elevated from base-line levels in the order of 160–170 mg% to ranges of 194–279 mg%. Plasma alkaline phosphatase levels varied erratically between 8.7–25.9 units. No definite pattern was obvious in these results. Plasma glutamic oxalacetic transaminase (GOT) levels ranged from 270–383 units[6] before induction of kidney injury and from 400–462 units at termination of the cases. Lactic dehydrogenase (LDH) activity was similarly markedly elevated in the plasma of these animals, and continued to rise to levels of 2150–3260 units[6] after kidney injury. Aldolase (Ald) and phosphohexose isomerase (PHI) activity in plasma continued to increase in the same manner to reach terminal levels of 41–252 units[6] and 253–303 units[6] respectively. Isocitric dehydrogenase (ICD) remained at all times well within normal limits, figures in the order of 230–264

units[6] being found in all six cases. Glutamic pyruvic transaminase (GPT) values similarly remained at baseline levels of 35.5–67 units[6] in the plasma of five out of the six cases. Sheep 20103 died having levels of activity of 130 units for this enzyme in its plasma.

(*e*) *Kidney Function*: Before dosing of the methyl cellosolve and dioxan, blood urea nitrogen levels ranged from 16–26 mg% in all six animals. Dosing was followed within twenty-four hours by a sharp rise in the blood levels of this compound. Four days after dosing dioxan, values in the order of 78–83 mg% were found and terminal values of 90–121 mg% were the rule. Creatinine similarly rose rapidly from pre-dosing blood levels of 0.3–0.7 mg% to terminal values of 2.6–9.5 mg% depending on the severity of the uraemia.

In general blood uric acid levels remained mildly elevated at 1.49–3.36 mg%, and amino acid levels in plasma remained unaltered throughout the entire experiment at 3.73–5.68 mg%.

In none of the six cases was bile duct occlusion followed by polyuria. Pre-operation urine excretion ranged from 200–258 ml per 24 hours and after operation, from 240–700 ml per 24 hours. Dosing was followed within two days by frank oliguria and towards the end of the experiment the 24 hour output of urine ranged in the six animals from 10–80 ml.

In five out of the six animals the urine specific gravity remained at the low post-operation values of 1.010-1.015.[6] In sheep 16551, the values after dosing varied from 1.018 to 1.024. In all cases the urine varied from markedly acid to neutral in reaction (pH 4.0–7.0) and albuminuria was severe. Haematuria was an infrequent finding.

(*f*) *Adrenal Function and Electrolyte Balance*: Blood sugar levels remained within normal limits throughout the experiment, values of 33–66 mg% being obtained.

In three of the six animals (sheep 20134, 20151 and 16551) no change in the total plasma protein levels was apparent. These were the same animals in which no red cell dyscrasias were obvious. The remaining three animals underwent a decrease in plasma protein concentration of the order of 7.85 to 6.40 g% as the nephritis developed, which coincided with a decrease in red cell count, packed cell volume and haemoglobin. It is evident that haemodilution, as a result of water retention, marked the closing stages of the syndrome in these animals. The α2-globulin fraction and in most cases the γ-globulin fraction, rose to above the baseline values, the former ranging from 0.85–1.17 g% and the latter from 1.38–2.86 g%.

Severe hyponatraemia and hypokalaemia were a constant feature in all six animals. Plasma sodium levels fell from pre-dosing levels of 144–147 meq/L to 124–134 meq/L, and potassium levels from 4.0–5.0 meq/L to 1.5–3.0 meq/L at termination. Hypochloridaemia was seen in five out of the six animals, terminal values of 78.2–92.7 meq/L being found. All six animals suffered a severe decrease in plasma bicarbonate values, the ranges found before death being 8.0–17.0 meq/L (figures of 8.0–10.0 meq/L were found in four of the six cases before death).

Plasma inorganic phosphate levels rose markedly soon after dosing to reach values of 9.29–14.03 mg% before death. In three instances these high values were associated with high plasma magnesium values, namely 3.31–5.95 mg%.

In all six animals absolute eosinophile counts fell from pre-operation levels of 125–290/cu mm. to 0–20/cu mm. and remained as low as this for the duration of the experiment.

(*g*) *Copper Metabolism*: Hypercupraemia was a constant feature after dosing the nephrotoxic glycols. Total plasma copper values rose rapidly from pre-dosing levels of 111–200 mcg% to 270–300 mcg%. These high values were associated with increased levels of firmly bound copper[6] and corresponded with steady and marked increases in plasma ceruloplasmin levels from pre-dosing values of 5.4–12.3 mg% to terminal values as high as 15.7–24.4 mg%. In only two instances was any loosely bound (albumin) copper[6] found in the plasma of these cases after dosing. An isolated value of 20.3 mcg% was found for the plasma of sheep 20103 three days after dosing and a similarly isolated value of 10.14 mcg% for the plasma of sheep 20134, also three days after dosing. In both cases ceruloplasmin levels only increased terminally.

Red cell copper levels were high in all six cases during the second to third days after

dosing, values of 203–508 mcg% being found. During the terminal stages of the disease these values fell in all the animals to within the range of 132–244 mcg%.

The range for urinary excretion of copper by sheep weighing between 50–65 lb and maintained on a diet of green lucerne, maize and water *ad libitum* was shown to be 1.14–214.5 mcg per 24 hrs with a mean value of 67.7 mcg per 24 hrs.[6] Common bile duct occlusion has little effect on this excretion while the syndrome is uncomplicated. The urinary excretion of copper is markedly decreased after acute nephritis has become established. The range for the last three days of the combined syndrome in all six animals was 0–40 mcg% with a mean value of 10.1 mcg%.

(*h*) *Iron Metabolism*: The marked drop in plasma iron levels, which was reported previously to occur immediately after bile duct occlusion[6], was observed once more in all six cases used in the work. Values as low as 31.3–43.8 mcg% were recorded in two of the sheep. Predosing levels were in the range 53–175 mcg%. After nephritis had been induced, the plasma levels of iron continued to rise slowly to reach terminal values of 69–205 mcg% in all instances.

2. Effects of sham operation

The only feature of note in the haematology of this control animal (19773) was a mild leukocytosis. Total leukocyte counts rose from a pre-operation level of 8.5×10^3/cu. mm. to 10.6×10^3/cu. mm. four days after operation.

A mild and very transient hyperbilirubinaemia appeared in this animal during the 24 hours following the sham operation. Total bilirubin levels rose no higher than 0.3 mg%, all the pigment being bilirubin. This phenomenon has been noted before in sheep subjected to various forms of stress.[2, 7]

No disturbances of bile acid or porphyrin metabolism were noted.

The flocculation and turbidity tests for liver function remained negative, plasma alkaline phosphatase varied between the base line limits of 11.04–14.9 units[6] and total plasma cholesterol levels remained constant at 121.2–122.5 mg% throughout the experiment. GOT levels never rose above 175 units,[6] but LDH, Ald and PHI activity levels rose rapidly in the plasma during the three days following the sham operation, the former two levels falling over the next three days. Values of 2090–1280; 67–29 and 198–285 units[6] were obtained respectively for the period of six days following the operation. The levels of GPT and ICD activity in the plasma remained well within normal limits[6] throughout the entire experiment.

No disturbances of kidney function or abnormalities in the urine excreted were noted at any time during the experiment. Blood urea nitrogen, creatinine, uric acid and amino acid levels ranged between 18.4–20.2; 0.3–0.7; 0.75–1.24 and 4.86–5.92 mg% respectively.

Blood sugar levels remained normal throughout and total plasma protein values fluctuated between 6.6–7.87 g%. Globulin levels rose slowly during the operation, the rise being due to an increase in α2-globulins from 0.69–0.98 g% and in γ-globulins from 1.72–1.97 g%. The rise in α 2-globulins coincided with a rise in plasma ceruloplasmin levels from a pre-operation value of 3.4 mg% to 7.8–9.0 g% during the period after operation.

Sodium, potassium, chloride and bicarbonate levels in plasma remained constant at 145–147; 4.3–5.0; 105–109 and 24.0–26.0 meq/L respectively. Plasma inorganic phosphate and magnesium levels never varied significantly from the pre-operation levels of 5.82 and 2.5 mg% respectively.

The only indication of an adrenal response to the stress of the operation was a prompt fall in the absolute eosinophile count from pre-operation levels of 130–280/cu. mm to 10/cu. mm on the day following the operation, and 0/cu. mm for the remaining six days of the experimental period.

Red cell copper rose sharply on the day following the operation from a base line value of 75 mcg% to 227 mcg%, falling rapidly again thereafter to reach a value of 113 mcg% five days later. Total plasma copper remained within normal limits[6] throughout the experiment but the labile albumin copper[6] disappeared from the plasma throughout the post-operation period. This was associated with the rise in ceruloplasmin (within the normal limits of this plasma constituent in sheep[6]) mentioned earlier.

Urine copper levels remained within the normal limits mentioned earlier over the entire experiment.

Plasma iron values fluctuated between 75–100 mcg% throughout the experiment.

3. Effects of induced nephritis

The only salient features in the chemical pathology of case 4680 were those concerned directly with kidney function, as could be expected. The sheep survived for seven days after dosing the two nephrotoxic agents. Blood urea nitrogen and creatinine rose rapidly from predosing levels of 20–27.6 and 0.5–0.9 mg% respectively, to final values of 238 and 24.2 mg% respectively. These changes coincided with the appearance of a progressive oliguria and albuminuria.

Blood sugar levels remained normal but the animal went into an Addisonian response to acute nephritis. This was manifested by hyponatraemia, hypochloridaemia and hyperkalaemia, mean values of 138, 80.4 and 5.8 meq/L being obtained for plasma sodium, chloride and potassium over the fourth to seventh days after dosing.

Total plasma copper levels remained constant throughout the experiment between the limits of 83–100 mcg%, but urinary copper excretion fell from predosing levels of 104–143 mcg per 24 hours to zero two days after dosing and remained there until death.

Discussion

The surgical manipulations involved in a sham occlusion of the common bile duct in the sheep produce the following clinical pathological picture: mild leukocytosis, very mild and transient hyperbilirubinaemia, markedly increased plasma levels of LDH, Ald and PHI, mild fluctuations in plasma electrolyte levels and severe eosinopaenia. These changes are manifestations of stress and extensive tissue damage, as reported earlier.[2, 6, 7]

The most noteworthy disturbances in copper metabolism are the transient rise in red cell copper immediately after the sham operation, and the slow but sustained rise in plasma ceruloplasmin levels, within the normal limits for this constituent, during the week following the operation. These changes may reflect a temporary embarrassment of biliary copper excretion consequent to the stress of the operation, in the same way that bilirubin excretion is temporarily hindered. They are changes which become most pronounced when the common bile duct is occluded and colestasis is induced.[6]

Acute toxic nephritis as induced in this work produces: a severe leukopaenia, oliguria, albuminuria, uraemia, hyper-creatininaemia and severe electrolyte imbalances indicative of adrenal exhaustion. Urinary excretion of copper, a secondary pathway of excretion in normal sheep,[6] fails completely but the plasma levels of the element are not affected. The rate at which the plasma levels of urea and creatinine rise after dosing the agents concerned and the rapidly attained high values attest to the severe degree of renal failure which is induced.

The superimposition of a rapidly developing complete renal failure on common bile duct occlusion tends to accentuate very sharply some of the disturbances found in the latter condition and introduces some other complications of importance. Hyperbilirubinaemia, clinical icterus and photosensitivity increase rapidly in intensity owing to the abolition of the urinary excretion of bilirubin conjugates and porphyrins. Although not determined in this work, plasma bile acid levels probably increase rapidly since their primary pathway of secretion is blocked and the secondary one also abolished, as is apparent from the disappearance of bileaciduria.

The reaction to the combined stress of bile duct occlusion and acute kidney injury is characteristically severe and is manifested by disturbances such as hypervolaemia, acidosis, hyponatraemia, hypokalaemia, hypochloridaemia, low plasma bicarbonate levels, excretion of acid urine and eosinopaenia. Hyperphosphataemia and hypermagnesaemia are terminal changes which appear to be related to the rapidly developing kidney failure rather than to adrenal failure.

Blood copper levels are markedly affected. The combination of blockage to the primary and secondary pathways of excretion of this element and the severe stress reaction produces a very sharp and rapid rise in the total plasma copper and particularly in the ceruplasmin fraction. As pointed out in the previous paper of this series[6]

total plasma copper levels will rise terminally in common bile duct occlusion. The magnitude of the increment is increased and its advent brought forward by superimposing the disturbances described here on a developing cholestasis of short standing. As also observed earlier,[6] red cell copper levels increase for a short while after blocking the primary biliary pathway of copper excretion. The increased levels of red cell copper are seen again for a short while after urinary copper excretion comes to a stop. This behaviour of the ovine erythrocyte may represent a useful safety mechanism by which small amounts of free copper which are suddenly returned to the bloodstream can be trapped and held until the liver can render it innocuous by binding to cuproproteins such as ceruloplasmin.

The results of the liver function tests which can be used in the diagnosis of common bile duct obstruction in the sheep [6] are not significantly altered by the superimposition of acute kidney injury. Positive colloidal gold tests are found as a terminal feature of the combined syndrome. As found before[6] the assay of plasma GPT, ICD and alkaline phosphatase yields no information of value in conditions like these. Increases in GOT, LDH, Ald and PHI are not a part of the chemical pathology of bile duct occlusion, but are a reflection of the large scale tissue injury following the experimental procedures.

Acknowledgement

I am fortunate in having as my professional assistants, Adriana Wagner, Anna Brink and Lulu van Zyl, and Messrs. P. J. de Wet, R. Gray and R. J. J. Briel as my technicians. Without their able and willing assistance this work could never have been undertaken. Professor Richard Clark was always on hand with valuable advice and guidance. The Chief, Veterinary Research, Onderstepoort, is thanked for permission to publish this work.

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Jl S. Afr. vet. med. Ass. 38 (4): 389-394 (1967)

SKEWFACED JERSEY CATTLE IN SOUTH AFRICA

F. N. BONSMA*, J. G. BOYAZOGLU** and H. P. A. DE BOOM***

SUMMARY

Nine directly related cases of skewfacedness in Jersey cattle were investigated. These cases were compared morphologically with three non-related skewfaced individuals. The available data indicate that the complex consists of two types, primarily affecting (*a*) the nasal region (campylorhiny) and (*b*) the maxillary and mandibular region (campylognathy) and that the latter is probably due to a single autosomal recessive gene. In these cases the deviation may occur primarily in the maxillary or in the mandibular region. Defects of teeth or of the temporomandibular joint do not appear to have a causative effect neither does horn weight. Besides the hereditary form of the abnormality, non-hereditary phenocopies presumably also occur.

INTRODUCTION

Calves born with asymmetric or skew faces, giving the impression of a hypotrophic condition of certain muscles, are found occasionally in cattle populations. Calves born with straight faces sometimes, also, progressively develop skew faces.

According to the report of the Netherlands Commission on Hereditary Defects[1], two Friesland bulls used for artificial insemination produced skewfaced calves which apparently were fully viable. Gotink and coworkers[2], also in the Netherlands, drew attention to several such cases and mentioned that "these deviations occurred apparently in the progeny of specific bulls". In South Africa similar observations have been made by Bonsma[3] and others in Afrikaner cattle (Fig. 1).

This suggests that skew faces cannot always be attributed to chance and that, at least in some of the cases observed, they may be due to an hereditary cause. On the other hand, cases of presumably non-hereditary skewfaced cattle are known: such a case occurred in one of a pair of Jersey-Friesland crossbred identical female twins purchased from a private farm by the Animal Husbandry and Dairy Research Institute in the early 1960's. A similar case of a non-hereditary skew face in one of a pair of identical Jersey twins was described by Hancock[4] in New-Zealand.

HISTORICAL BACKGROUND

In 1951, as the result of a controversy which arose during the judging of Jersey cattle at a South African show, the interest of two of the authors was aroused as to the possible existence of hereditary skewfacedness in Jerseys. They were consulted on two aspects of the problem of skewfacedness:

(*a*) to determine what extent of deviation from the longitudinal facial axis, in either the upper or lower facial bone structure, should be regarded as abnormal;

(*b*) to what extent skewfacedness is an hereditary character.

At that stage little was known of the hereditary aspects except for the case reported by Hancock[4].

In 1956, the first author visited Jersey island, and came across a very skewfaced bull, "Prince of Lords III" (Fig. 2). This bull was extremely well bred and a direct descendant of "Oxfordia's Oxford Lad", perhaps one of the most famous sires bred on the Island of Jersey, particularly

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from a production point of view. Although this is one of the few known cases of skew faces appearing in animals descending from the Oxfordia line, it is interesting that "Prince of Lords III" was inbred to two of the best known Island bulls, namely Prince of Bagot and Oxfordia's Lad. The breeder offered the bull as a present; he could not remember any other cases of skewfacedness in his herd. During the same year "Prince of Lords III" and five skewfaced heifers bought at random were imported to South Africa and kept on the experimental farm of the University of Pretoria and later at the Potchefstroom College of Agriculture.

From 1956 to 1958 the five imported skewfaced heifers were bred to "Prince of Lords III", but up to the age of twelve months none of the progeny showed any phenotype signs of skewfacedness. It is unfortunate that, as so often happens, no further controlled breeding tests were conducted and no further experimental data were collected.

In October, 1959, "Prince of Lords III" was transferred to the experimental farm of the Institute at Irene and was used there[6] until November, 1963. He produced 44 female progeny of which five were his own granddaughters. The male progeny was not recorded because of the prevailing husbandry system.

Results

Breeding data

The living female progeny of the bull were examined for signs of skew faces every six months from October, 1961, to November, 1964[7]. In eight animals, several of which showed no visible signs of the condition at birth, pronounced skew faces developed during these three years (Fig. 3). Of these eight skewfaced females, two were by "Prince of Lords III" out of his own daughters, two were the progeny of purebred skewfaced Jersey cows purchased because they were closely related to one another was well as to "Prince of Lords III", and one was the progeny of a phenotypically normal cow closely related to all abovementioned animals. Unfortunately no information could be obtained concerning the pedigrees of the dams of the remaining three skewfaced daughters of "Prince of Lords III": they were grade cows bought in the Transvaal.

It must also be mentioned that three cases of skewfaced Jerseys (a cow, a heifer and a bull calf, all related to "Prince of Lords III" through the same Jersey Island bull) were recently brought to the attention of the authors.

Anatomical description

Of the nine cases diagnosed clinically, six heads were available for *post-mortem* examination, (those of the bull, one adult cow and four juvenile females). Three were dissected in the fresh state and three after preservation by 4% formaldehyde perfusion. The skulls were subsequently macerated.

No pathological condition could be found in any of the soft tissues to account for the skewness. In the fixed material neither relative hypertrophy nor hypotrophy of the individual muscles was evident upon comparison of the left and right sides; similarly, no discrepancy could be detected between the morphology of the infra-

Table 1 Female progeny of Prince of Lords III bred at the experimental farm at Irene

Prince of Lords bred to	His own non-skewfaced daughters (Phenotypically)	Skewfaced cows closely related to Prince of Lords	Non-Skewfaced cows with varying or unknown degree of relationship to Prince of Lords	Total
Normal Female Progeny	3	0	44	47
Skewfaced Female Progeny	2	2	4	8
Percentage Phenotypically abnormal Progeny	40%	100%	9%	17%

orbital arteries or of the maxillary nerves supplying the region obviously involved and the sound side. Histological examination of the muscles, arteries and nerves yielded no pertinent information.

In four cases, all juvenile females, the teeth were in perfect condition. In the one adult cow, which showed a slight deviation to the right, the first premolars of the lower jaw were absent and the second and third premolars of the upper jaw had dropped out or broken off. The skull of the mature bull, "Prince of Lords III", was strongly deviated to the right. The molar teeth had undergone uneven wear ("wave mouth") and the left upper second molar tooth had dropped out: extensive erosive periodontitis had taken place (Fig. 5a).

All the juvenile animals had been dehorned at an early age and the crania were typically those of polled cattle. The adult cow had a short cornual process present on the right and a bony scar on the left side, consequent upon dehorning at a late stage. The bull had short horn remnants, measuring 7 cm in length and 6.5 cm in diameter at the base.

The temporomandibular joint was affected in two cases: in the bull there was an erosion of 4 mm on the temporal condyle ipselateral to the direction of deviation of the face, and in the one heifer the mandibular condyle presented a 3 mm erosion on the contralateral side.

In three cases the karyotype was determined and found to be normal[8].

The viscerocranium of the bull (Figs. 4a, 5a & 6a) and of one heifer had undergone marked (16°) to moderate ($4\frac{1}{2}$°) deviation to the right. That of two other heifers had deviated strongly (13°) to the left (Figs. 4b, 5b & 6b). The axis around which the deviation had occurred lay in the median plane and extended diagonally from the posterior nasal region (at, or up to 3.5 cm orally to, the nasion) to the posterior point of the palate (staphylion). On visual inspection it was clear that the deviation was due to growth inhibition on one or the other side of the face. Some rotation of the viscerocranium had occurred concomitantly, usually, but not always, to the opposite side of the deviation, indicating that growth inhibition had occurred along a line not coincidental with the longitudinal facial axis (Figs. 4, 5 & 6). A detailed analysis of the data is being undertaken to define the site and direction of growth inhibition more accurately.

The mandibles of the last-mentioned four cases had undergone a similar deviation in conformity with the upper jaw; in two cases to the same degree, so that the prosthion lay in the same vertical plane as the infradentale. In the two other cases the deviation of the lower jaw had lagged behind slightly, so that the prosthion appeared displaced and thus out of line, equivalent to one quarter the width of the first incisor tooth in the direction (left or right) in which the viscerocranium had deviated. (It is interesting to note that, with due care, the same degree of displacement could be determined on the macerated skull as in the live animal, whereas discrepancies occurred when the relative position of upper and lower jaw was observed in formalin fixed material.)

The viscerocranium of the mature cow was deviated slightly (2°) to the right. This degree of deviation could be matched in a normal Jersey skull. The mandible was remarkable in that the left half was slightly longer (in straight linear measurement) and straighter, whereas the right half was slightly shorter but more curved towards the left with a tendency to recurve distally — reminiscent of a very shallow sigmoid curve. The overall effect this created in the live animal was that of a slight deviation to the left, and as such it was recorded clinically. The consequent malocclusion resulted in the prosthion lying opposite the middle of the first incisor, i.e. the upper jaw appeared "one half tooth out of line to the right".

The calvarium of one heifer was perfectly straight but the mandible had been deformed in basically the same way, so that the prosthion lay opposite the middle of the right second incisor tooth and the left incisors 2, 3 and 4 did not lie in apposition to the dental pad. Once again the clinical appearance of a skew face to the left was created.

The cranium of the abnormal member of the Jersey × Friesland crossbred twin heifer, mentioned in the introduction to this paper, was distinctly although moderately deviated (4°) to the right. The only noticeable difference in this case was that the axis around which slewing had occurred extended ventrally to the palatorale instead of more posteriorly to the staphylion.

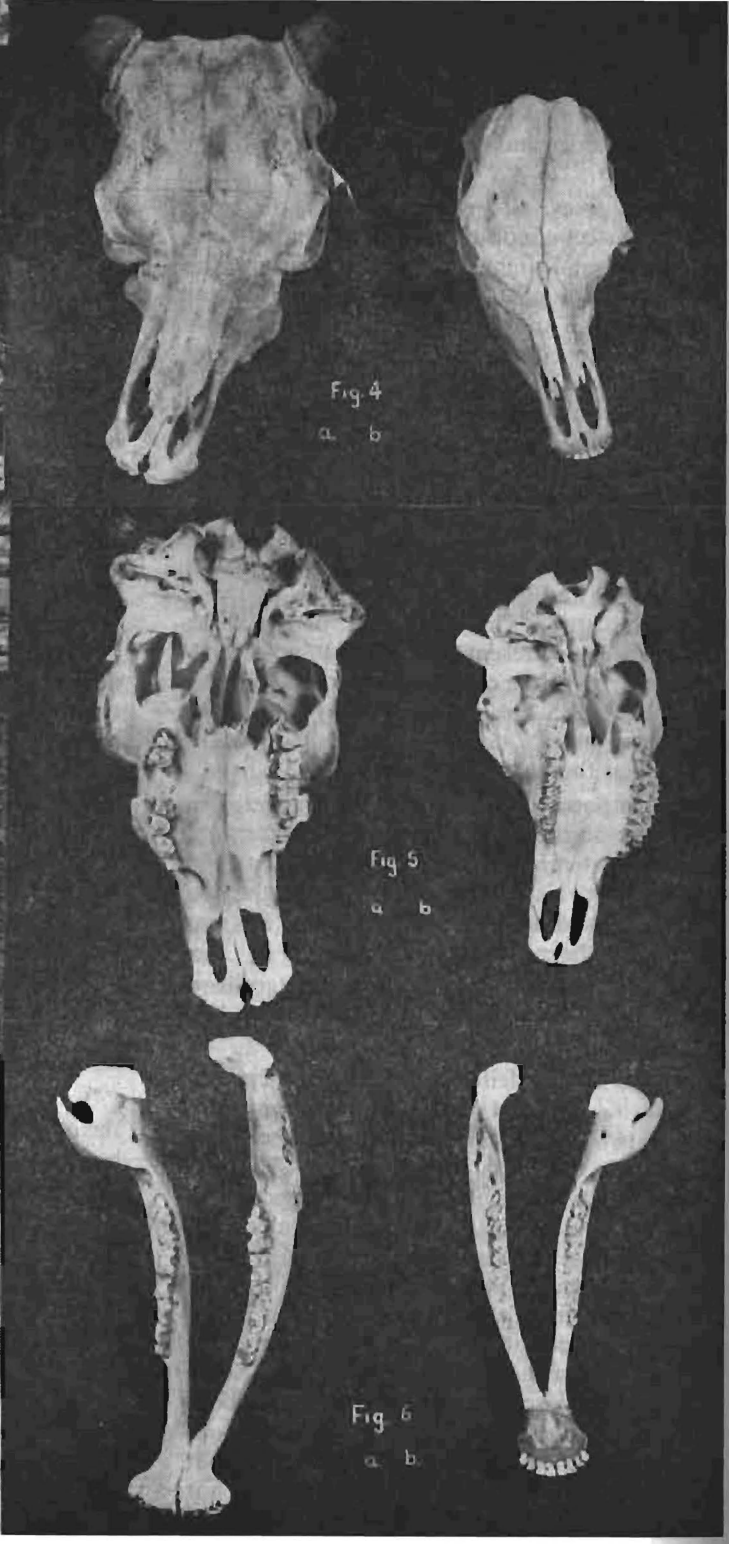

FIG. 1. Skewfaced Afrikaner in the Northern Transvaal.
FIG. 2. PRINCE OF LORDS III, slaughtered on the 22nd November 1963. (9½ years old, 1056 lb live-weight).
FIG. 3. J112, daughter of PRINCE OF LORDS III and a grade Jersey cow.
FIG. 4. (a) Skull of PRINCE OF LORDS III and (b) his daughter J54 (dorsal view).
FIG. 5. (a) Skull of PRINCE OF LORDS III and (b) his daughter J54 (ventral view).
FIG. 6. (a) Mandible of PRINCE OF LORDS III and (b) his daughter J54 (dorsal view).

For the sake of comparison a search was made among the Onderstepoort teratological collection and two campyloprosopous bovine skulls were found. These were from oxen: an Afrikaner and a crossbred Afrikaner respectively. In these cases, however, the deviation had affected primarily the nasal bones and septum, as well as the turbinate bones, producing a distinct twist in the dorsal nasal region although the bony palate was also affected. One could well designate these two cases as skewnosed (campylorhinous) instead of skewfaced.

Of the 47 phenotypically non-skewfaced female progeny of "Prince of Lords III", born at Irene, 33 were carefully examined. Only 18 of them were found to be completely normal; the other 14 suffered malocclusion, the midline of the dental pad of the upper jaw, i.e. prosthion in the skull, being displaced relative to the incisors as follows:

¼ tooth out of line to the left, six cases;
¼ tooth out of line to the right, three cases;
½ tooth out of line to the left, two cases;
½ tooth out of line to the right, two cases;
1 tooth out of line to the right, one case;
One animal had a short underjaw.

Unfortunately, none of these cases was available for examination *post mortem*.

Discussion and Conclusions

From a morphological study of the material available, it may be postulated that skewfacedness (campolyprosopy) can be classified into two main categories, namely skewnosedness (campylorrhiny) and skewjawedness (campylognathy). The latter condition may be subdivided further into campylognathia superior and campylognathia inferior, depending on whether the skewness or lateral deviation has affected primarily the maxillary or the mandibular component of the viscerocranium. It is concluded that the defect is due to progressive growth inhibition of the left or right facial region. Incidentally, in these cases, lateral malocclusion may or may not occur, depending on whether the degree of deviation is similar or dissimilar in the maxillary and mandibular components of the viscerocranium.

Quite apart from skewfacedness, lateral malocclusion may occur without anatomical deviation of the facial axis, neither of the upper (maxillary) nor of the lower (mandibular) bony components. This type of malocclusion conceivably may be due to tooth defects, temporomandibular pathology, or even to the animals' chewing habit and thus within the range of what would be considered normal physiological movement, such as observed in the fifteen phenotypically normal, non-skewfaced female progeny of "Prince of Lords III".

It can be considered that neither tooth defects, nor defects of the temporomandibular joint, nor horn conformation played a rôle in producing the facial deviation in the case of true campylognathy described.

Concerning the hereditary aspects of true campylognathy, the high incidence of skewfaced calves born to "Prince of Lords III" at Irene (Table 1) indicates that in most, if not all, of the cases observed the abnormality was genetically determined. Although the available information is not entirely adequate, it is evident from table 2 that a good case can be made out for an autosomal recessive gene controlling an hereditary tendency to skewfacedness. It should be mentioned that the 9% abnormal progeny (Table 2) obtained when breeding "Prince of Lords III" (ss) to phenotypically normal unrelated (probably SS), or related (probably Ss) cows, is acceptable. Although the theoretical range of expectancy of the abnormality being expressed is 0–50%, the true percentage must be much nearer to 0% than to 50% because the number of SS cows will probably be much larger than the number of Ss cows.

The question arises whether the two observed cases of primarily inferior campylognathy can be considered as being genetically similar to those of primarily superior campylognathy. Ontogenetically the maxilla and mandible both arise from the first branchial arch. At this stage of the investigation there appears to be little justification to separate upper and lower components of this primary structure when considering the hereditary aspects. Even when excluding these two cases from the data in Table 1, the obtained percentage of abnormal progeny remains within the probability limits of a single recessive gene.

As a growth inhibiting factor is involved, the degree of skewness is dependent upon age of the individual in the first instance; the existence of modifying genes and the influence of external conditions cannot be excluded.

TABLE 2 EXPECTED PATTERN IN THE CASE OF AN AUTOSOMAL RECESSIVE GENE

Prince of Lords III	Phenotypically Normal Daughters (Ss)	Abnormal, Closely Related Cows (ss)	Normal Unrelated and Related Cows (SS or Ss)
Expected percentage of abnormal progeny	50%	100%	0–50%
Obtained percentage of abnormal progeny	40%	100%	9%

Supporting evidence of the hereditary nature of this abnormality may be found in the fact that of the 299 female calves not related to "Prince of Lords III" and born during the same period at the Irene Research Institute, not a single one had a skew face at birth or developed one subsequently. In fact, only one other case of a skewfaced animal was ever observed on the farm and that was the presumably non-hereditary case in one of a pair of identical twins already mentioned. Consideration of this case, as well as that described by Hancock[4], leads one to conclude that non-hereditary phenocopies of campylognathy do occur.

ACKNOWLEDGEMENT

The Chief, Veterinary Research Institute, is thanked for his co-operation and for his permission to H. P. A. de Boom to publish this paper.

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Jl S. Afr. vet. med. Ass. 38 (4): 395-398 (1967)

SURGERY OF BOVINE IMPOTENTIA COEUNDI

II Short, Contracted and Immobilised *Musculi retractores penis*

C. F. B. HOFMEYR*

SUMMARY

Eleven of a series of 176 bulls suffered from various kinds of pathology of the *Mm retractores penis* and adnexa. The opinion is advanced that in young bulls without a history of previous service, the term *short* and not *contracted* retractor penis muscles must be used, where these are of inadequate length. Arguments are put forward in favour of *short adnexa* instead of short *retractor muscles* being the cause of failure of erection in some cases. In older bulls with a history of service, contraction and atrophy of these muscles may occur from disuse resulting from preputial lesions or arthritis. In two bulls treatment was refused by the owners. Of the remaining nine, recovery was achieved in six by passive stretching of the penis or sectioning of the *Mm retractores penis* at a site immediately below the ischial arch. In three bulls myectomy was carried out just above the sigmoid flexure but all the operations failed

INTRODUCTION

The conclusions drawn from observations on a group of 11 bulls, suffering from short, contracted or immobilised *Musculi retractores penis* form the material of this paper. These cases are part of a consecutive series of 176 bulls with surgical penis pathology described in detail elsewhere[1]. General considerations were outlined in the first of these articles[2].

Any form of "cohibition"[1,2] produced specifically by impaired function of the *Mm retractores penis* only is considered, whether this impairment be due to pathology of these muscles or due to their immobilisation as a result of a pathological state in the surrounding fascia.

INCIDENCE

The breed distribution of the 11 bulls was as follows: four Afrikaner bulls, two Jerseys, two Frieslands, one Guernsey, one Brahman and one Hereford. Their ages ranged from one to nine years.

AETIOLOGY AND PATHOGENESIS

A clear distinction must be drawn between the three conditions affecting the normal physiological efficiency of these muscles.

1. The term "short *Mm retractores penis*" should be confined to those conditions where the muscles are hypoplastic. This form has been recognized in the literature[3] and has been reported heritable as a recessive character, and by definition must be congenital. Inadequate relaxation[7,9,10] and neurogenic factors have been incriminated[3]. In my opinion the latter state is a hypothetical one

2. The term "contracted" *Mm retractores penis* should be confined to those states in which the muscles have been affected by changes other than true hypoplasia. In this respect fibrosis[3], chronic productive non-purulent myositis – which is seen on necropsy as pearl string swellings[9] – and rupture of muscle fibres with haemorrhage attributable to forceful forward thrust of the penis during erection[9] have been described.

Atrophy of the retractor muscles belongs to this category, but apparently the only previous mention of this is by Hofmeyr[1]. Certain bulls may serve normally for years and then become unable to extrude their penises due to pull by the retractor muscles. These cases have been

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Fig. — Delivery of Mm. retractores penis for ischial myectomy.

found to have either arthralgia, or painful or stenosed prepuces. Erection is thus discouraged or impossible for a prolonged period until the conditions of the joints or prepuce is rectified. It is contended that disuse atrophy of the retractor muscles occurs in association with the contraction. This focusses attention on the physiological importance of spontaneous erection in the early morning as occurs in normal bulls.

3. Tight or contracted penis adnexa is a new concept[1]. Paralysis of the retractor penis muscles (e.g. as induced by pudendal block) leads to "protentio"[1] of the penis, yet, after myectomy for short or contracted retractor muscles, penis prolapse does not occur. This shows that after the operation tissues other than the retractor muscles must be responsible for preventing such prolapse. This contention is further strengthened by the observation that, sometimes in the very young bull, which has never been capable of service, a single forcible extrusion of the penis permits subsequent normal erection. As no pathology of the retractor muscles would be rectifiable in this manner, the opinion is held that sometimes the surrounding fascia and elastic fibres are tight or short and responsible for "retentio penis"[1]. If this contention is ever confirmed, it poses the question as to whether tight adnexa are inherited. If so, it must be established whether the genetic transmission is identical with that of short retractor penis muscles and whether the inheritance of the latter state should be reviewed in the light of possible confusion in the past between tight adnexa and short retractor muscles.

Diagnosis

The clinical diagnostic methods have previously been described in detail[1,2] but the history and observation of the bull at attempted service, provide valuable additional information[1]. There might be a history of the young bull never having been able to extrude his penis for the full distance. This can indicate either short retractor muscles[1,3,6,10,11,12] or tight adnexa[1]. The bull then lacks copulatory thrust[3,6,11], although there is normal libido[6]. Ordinary general examination is then negative[6,11]. Other bulls might have a history of normal service, but subsequently emergence of the penis at erection is limited or prevented, in spite of absence of pathology distal to the attachment of the retractor penis muscles[1]. In these cases atrophy of the retractor penis muscles has been found to be a cause.

Treatment

The treatment has to be tailored according to the pathological state of the retractor penis muscles and/or adnexa.

Where a condition is genetically transmissible, treatment may be contra-indicated[5,8]. It is advisable, however, to consider each case on its merits as no objection can be raised to treatment, for example, if the offspring of such a bull are destined to be slaughtered as baby beef.

Short *Mm retractores penis* are generally regarded as hereditary. In view of the statements made earlier, the genetics of this condition

should be reviewed. It is wise, however, to inform the owner of the possibility of hereditary transmission and to enquire whether treatment is desired. The other states of the retractor muscles and adnexa have not yet been shown to have a genetic basis.

The owner, on being advised of genetic implications, may refuse treatment. This happened in two cases[1]. Another old bull suffering from chronic tarsitis and carpitis and atrophy of the retractor penis muscles was not treated as the arthritis was incurable.

In short adnexa in young bulls and in atrophy of the *Mm retractores penis* in bulls having served well but then sustained injury preventing erection for some time, passive stretching of the penis after pudendal block is indicated[1].

In one 12 months old bull, normal service became possible after a single stretching (i.e. he had short adnexa[1]). In five older bulls atrophy of the retractor penis muscles was present. Stretching the penis, at first under pudendal block and then without block, led to recovery in three, while in the remaining two this treatment failed, necessitating operation.

If conservative treatment fails, myectomy of the *Mm retractores penis* is the next step.

Three sites have been described for this operation.

Myectomy at [1,11,14] or immediately ventral to the ischial arch, [1,6,14] has been described. In this area choice of the latter site precludes incision of the ischiocavernosus muscles and the operation is thus simplified.

Analgesia for this operation is achieved by low epidural injection as described previously[2] in order to keep the bull standing during surgery. After dividing the skin and fascia by means of a midline incision about 10 cm. in length, the two retractor penis muscles can be felt like two fairly firm cords. These are picked up with tissue forceps, the fascia is dissected from them and the muscles are delivered to the surface (fig.). Two catgut ligatures are placed about 5–7 cm. apart around the muscles and the intervening part is excised. Large blood vessels run in the centre of these muscles and bleed profusely on being divided unless previously ligated. Even though the myectomy leaves some space in the fascia, this must not be obliterated by suturing, because firm adhesion formation to the distal muscle stumps will be encouraged and cause failure of operation. The skin is closed with interrupted silk sutures.

Two bulls were operated upon in this fashion and both recovered. In one, histopathological examination of the resected muscles showed granulomata, necrosis and calcification.

Myectomy above the scrotum and posterior "S" curve of the penis has also been described[1,13]. But for the site, the technique is the same as described above. Three bulls were operated upon at this site but the operations were failures. In one of these bulls, which had an injury of the prepuce, well marked atrophy of the retractor penis muscles was diagnosed histo-pathologically. There was a tendency in these cases for the fascia (which is up to ten cm. deep) to form adhesions with the distal stumps of the retractor penis muscles.

As failure at the ventral site effectively rules out subsequent use of the dorsal site, it is patent that the latter should be employed first.

Evaluation

Six out of the eleven bulls were treated successfully. In three treatment failed and in two treatment was refused by the owners. Besides these two, failure was confined to those bulls which were operated upon above the sigmoid flexure. Conservative treatment by passive stretching of the penis, or, if the results are negative, myectomy just below the ischial arch, is indicated. Myectomy above the sigmoid flexure must, at this stage, be regarded as a last resort.

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Jl S. Afr. vet. med. Ass. 38 (4): 399-405 (1967)

SURGERY OF BOVINE IMPOTENTIA COEUNDI

III Surgical Pathology (1)at the Distal Bend of the Sigmoid Flexure of the Penis; (2)in the Area between the Scrotum and the *Fornix praeputii.*

C. F. B. HOFMEYR*

SUMMARY

1. The unsuccessful treatment of one case of deep abscessation at the distal bend of the sigmoid flexure of the penis is described.

2. Forty seven bulls with fibrosis, granuloma and/or abscessation of the penis between the scrotum and the glans which resulted from haematomata, were treated for impediment in protrusion of the penis. The cause of the haematomata, the significance of the resulting adhesions and the prognosis are discussed in detail. Existing methods of treatment are reviewed, and details of the treatment applied to the subjects of this report are furnished. Ten bulls failed to respond satisfactorily to this treatment.

1. PATHOLOGY AT THE DISTAL BEND OF THE SIGMOID FLEXURE OF THE PENIS

Only one bull in 176 cases[1,2] of *impotentia coeundi* suffered from pathology at the distal bend of the sigmoid flexure of the penis. This part, at rest, is well protected by deep fascia and, at erection, is still guarded by the preputial skin. No firm conclusions are justifiable on the strength of one case only whose comparative immunity to injury is indicated by the very low incidence in this series[1,2]. The skin over the area is, however, a favourite site for the attachment of ticks, particularly those with long mouth parts. As a consequence subcutaneous abscesses are quite common, but almost invariably too superficial to cause impotence.

In this one case the abscessation was deep and involved the sigmoid flexure, forming firm adhesions which prevented straightening of the penis after conventional treatment of the abscess. Massage, an effective treatment in the next group of cases, was ineffective as the adhesions were situated too deeply. The treatment in this particular bull therefore failed.

2. PATHOLOGY OF THE PENIS IN THE AREA BETWEEN THE SCROTUM AND THE FORNIX PRAEPUTII

Observations recorded under this heading are based on 47 of the 176 cases of *impotentia coeundi* which were studied[1,2]. This type of condition seems to be rather common.

The breed distribution of cases was as follows: Frieslands 10, Afrikaners 8, Herefords 5, Brown Swiss 4, Ayreshires 3, Simmenthalers 1, Drakensbergers 1, Brahmans 1, South Devons 1, Guernseys 1, Sussex 1, Aberdeen Angus 1, Aberdeen Angus x Galloway 1. Twenty-three were under three years, 11 were 3–4 years and 13 were over four years of age.

DESCRIPTION

All cases of penile or peripenile haematomas and/or abscessation causing granulations and adhesions near or around the penis at any site from the scrotum to the base of the sheath are included under this heading.

AETIOLOGY AND PATHOGENESIS

Haematoma formation consequent upon rupture of the *tunica albuginea* at the dorsal aspect of the penis opposite the level of insertion of *Mm retractores penis* has been referred to by several authors[1, 3–10]. Such injury was sus-

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pected in several of the cases mentioned above: only demonstration of a tear in the *tunica albuginea* during surgical exposure could have verified the aetiological diagnosis. This part is functionally predisposed to injury because it appears immediately in front of the preputial opening at full erection. Misdirection during the copulatory thrust exerts excessive pressure on the penis at the preputial orifice[4,8,10–12], which acts as fulcrum[10]. This happens particularly when the penis is directed downwards, or pushed against the cow's sacrum, or when the cow collapses[3,4,6,8–13]. Discrepancy in size of the sexual partners is thus a predisposing factor. Young bulls are most prone to this type of injury, because of their clumsiness[4,8], or as result of mounting each other[3].

Information collected in the present study[1] supports these opinions and indicates that the most important single factor is inexperience and possibly over-keenness of the bull, since almost 50 per cent of the cases in this series were younger than three years. Misbehaviour on the part of the cow is likely to injure the bull irrespective of his age and for this reason as well the type of penile pathology under discussion is relative to the mating technique of the bull.

Injury to the bloodvessels on the surface of the penis not necessarily in the nature of severe direct trauma, may produce even large haematomas. The erect penis is very susceptible to bruising and to such haematoma formation and inner layers of the prepuce may become lacerated. The presence of a laceration or scar usually cannot be established during the initial examination because cohibition prevents visualisation of all of the layers of the prepuce. After recovery, scars sometimes may be seen after natural erection, or after protrusion produced by pudendal block. Usually, however, the local bruising leaves no persisting signs.

Infection was present in one-third of the cases. This could have been introduced either through a wound in the prepuce, which is considered less likely in most cases, or via the systemic blood, the haematoma representing a *locus resistentiae minoris*. It has been shown repeatedly by others that *Corynebacterium pyogenes*, generally the commonest cause of abscesses in cattle, may be found circulating in the blood stream. Should these bacteria enter a haematoma, they will cause abscessation. This opinion has been expressed by others[3,4]. Abscesses may naturally arise independently[5,17–21].

Whether the haematoma becomes infected or not or whether the abscess arises independently is immaterial, since either one invariably gives rise to extensive fibroplasia. As the mobility of the penis normally depends on layers of fascia, triply telescoped when the penis is at rest, the fibroplasia may anchor one or more of these layers to one another and to the *tunica albuginea*, resulting in partial or complete immobilisation of the penis. The increase in volume of tissue will also present obstruction to erection. These adhesions and granulomatous masses present the basic problem to be overcome in restoring the bull to normal sexual function.

Diagnosis

The clinical appearances of rupture of the penis and consequent development of a haematoma are well known, but include: *impotentia coeundi*, which is always immediate; there is a large swelling, which may cause the penis to prolapse[4,6]; shortening of the stride, arched back and even stiffness of the hind legs may be seen[6] although general manifestations are usually absent[3,4]. Initially pain prevents erection[11,12] which may also be due to disturbance of the reflexes and spasms of the retractor penis muscles. The blood supply is probably affected adversely[11]. The swelling is soft and fluctuating at first but later becomes hard and doughy, and the non-pigmented skin mottled with extravasated blood[6]. Urination is not hampered[6,14], although occlusion of the urethra has been mentioned[12]. In recent cases the penis can sometimes be delivered under anaesthesia, but in older cases this is impossible owing to the formation of adhesions[4].

The size of the haematoma is limited by the tenseness of the surrounding tissues; yet it may contain 1–3 litres of blood[6]. The blood clot becomes organized in two months or longer while the tear in the *tunica albuginea* is repaired during the shorter period[11]. "Phimosis" occurs, or ordinarily, with rupture and haematoma, "paraphimosis" may be present[3]. The fibrosis is also implicated as cause of a distorted penis[9]. Swelling in the region between the scrotum and the base of the glans may also be caused by an abscess which has a similar effect to that of a haematoma[5,17–21].

The special examination procedure of the penis and adnexa has been described previously[1,2]. The typical appearance of a haematoma of the penis, largely replaced by fibroplasia, is shown in figure 1. The swelling is then firm without fluctuation and no or very little blood can be withdrawn by aseptic needle puncture. Figure 2 shows and extensive prescrotal haematoma with very little fibroplasia and of fairly recent origin. Rupture of the *tunica albuginea* probably had occurred as indicated by the size of the lesion and the site. Where the bruising has been widespread round the body of the penis with dispersion of the blood over a large area, no localized haematoma is formed, but the *fornix praeputii* might be pushed forward causing a preputial prolapse (fig. 3). If injury is less widespread, the swelling tends to be fusiform, as in figure 4. The latter case developed an infection of the blood clot and discharged pus to the exterior through the skin. Occasionally the bruising causes relatively slight bleeding in the tissues but extensive oedema around the penis and of the prepuce (figure 5).

Fig. 1. — Fibrous tissue mass proximal to the *fornix praeputii*.

Fig. 2. — Prescrotal infected haematoma and fibrous tissue mass.

Fig. 3. — Oedema of the preputial area with prolapse of the preputial lining.

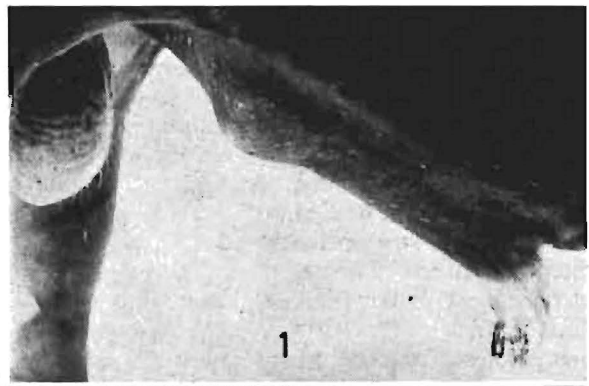
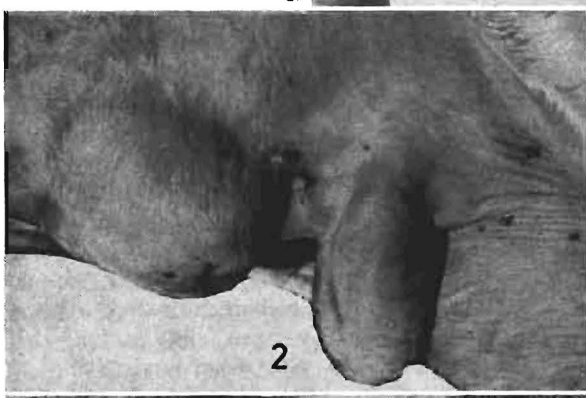
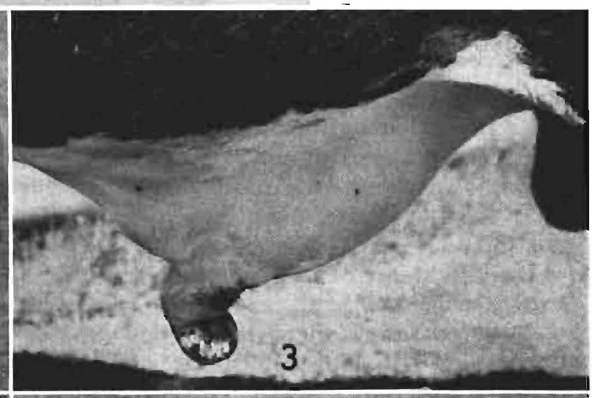
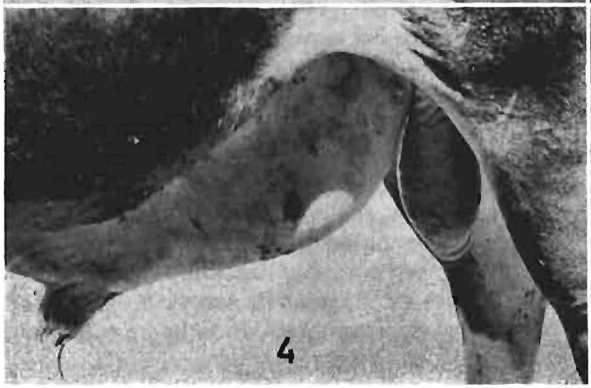


Fig. 4.—Peripenile infected haematoma with diffuse oedema.

Fig. 5.—Oedema of the preputial area.







The diagnosis of the type of lesion, then, is not a problem. Pudendal block will facilitate determination of whether any mobility of the penis is present[1,2]. Although not always possible, an attempt should be made to identify the layers of penis fascia affected, as this materially influences the prognosis: involvement of more than one layer adversely affecting the chances of recovery and prolonging treatment.

Prognosis

It is generally held that the prognosis of peripenile adhesions is poor[3,4,8,12,14,16]. Application of more rational treatment[1], as will be shown later, introduces a more optimistic note.

The size of the lesion is of fundamental importance. If it is large, it may mean either involvement of a considerable amount of fascia, or that relatively few fascial fibres are included in the lesion but that they have been pushed apart by increasing exudate or blood, these subsequently being replaced by granulation tissue. The effect is the same: movement of the penis during erection will be impeded.

The prognosis is not materially affected by the site occupied by the lesion in the area between the base of the scrotum and the glans. The fact that adhesions immediately anterior to the scrotum appear to have a more serious prognosis is not related to the particular area, but to the fact that rupture of the *tunica albuginea* here leads to a very large haematoma. It is this *extent* of the lesion and not the *site* that is significant.

The importance of the level of the lesion relative to skin and penis has been emphasised under *Diagnosis*. If the penis is firmly attached to the skin by scar tissue, i.e. if all the fascial layers, *tunica albuginea* and skin are involved, the prognosis is hopeless unless massage is supplemented by operation. Since abscesses, unless discharging through the preputial cavity, either rupture or are lanced through the skin, there is a tendency for a scar tissue connection to develop between skin and original lesion. Where the granulation mass surrounds the penis, or is directly attached to it, one is then faced with the problem of the mass having to move with the penis during erection. This problem prolongs treatment and, after successful erection, causes the exposed penis to appear thicker than normal.

In those cases where the granuloma is adherent to the skin and freely movable fascia lies between it and the penis, the problem is of lesser magnitude and the emerged penis appears to be of normal thickness. The same observations apply to a greater extent to a granulation mass lying at a level midway between penis and skin. By suitable treatment two layers of loose fascia can then be encouraged to slide freely—those between skin and granuloma and between granuloma and penis. In the latter type of lesion it is important to be able to establish whether one or more of the telescoped fascial layers is involved.

The size of the lesion is of over-riding importance: a small lesion at a level which carries a less favourable prognosis may, in fact, respond to treatment much more effectively than a large lesion at a level with a more favourable prognosis.

Treatment

There is diversity of opinion regarding treatment, but open surgery is usually favoured. The operation is performed under epidural analgesia with local infiltration[12] or general anaesthesia[6] at various periods between three and 14 days[5,6,12,15,16,20–22] after injury. The haematoma is exposed by making an adequate incision and the clots evacuated[5,6,12,15,19,20]. The tear in the *tunica albuginea* can usually be found and may be longitudinal, oblique or spiral[5] and 1–10 cm long[5,6,11]. It is sutured[3,6,14,15,19,20] followed by suturing of the fascia and then of the skin, a drainage opening being left sometimes. This allows subsequent treatment, e.g. with Nebacetin-hydrocortisone[5]. Leaving the wound open and packing with sulphanilamide has also been advised[16].

Opinions differ how soon after operation the bull should be exposed to cows in oestrum: immediately afterwards[6,12,15,19], after two weeks[16] two months[21] or after three months[20].

Conservative treatment, involving local astringent applications, prednisolone intramuscularly and daily contact with cows has been advised with success in one case and subsequent to operation in two others[12]. Anticoagulants in early cases, debriding enzymes and antibiotics are popular in America[3]. After non-operative treatment two months rest has also been advocated.[3]

Abscesses are treated by lancing and antiseptic irrigations[13,19–20] and even by total extirpation[5].

In one of the most recent publications on treatment of penile haematoma, Metcalf[23] advises delay for 5–7 days after injury and then injection into the haematoma of a solution of 125,000 units Varizyme (American Cyanamid Co.), 5 ml Daribiotic (S.E. Messengill Co.) and 250 ml physiological saline. Five days after injection, the tip of a suction tube is inserted into the haematoma through a stab incision and contents sucked out. The wound is not sutured and the bull rested for three months. Of 13 bulls operated upon by him, two required a second operation, one bull became infected and adhesions resulted. Eight bulls recovered fully.

Exposure of the affected bull to cows in season is basically in order but of limited application and subject to the following consideration. During the first stage of erection the penis is fairly flaccid and the forward propulsive forces are weak. If the cohibition is complete, or partial to the extent of allowing only a short section if the penis to protrude from the prepuce, there will be very little straining against the confining adhesions and the curative effect slight or absent. On the other hand, if the adhesions allow protrusion to a greater extent, they will allow erection to proceed to the second stage, in which the forward thrust is much more powerful: limiting adhesions then will be stretched. The favourable results sometimes achieved by allowing affected bulls to run with breeding animals are confined to this comparatively mild type of adhesion.

The main treatment used by the author was hot water application to the sheath with subsequent massage[1]. Surgery was only resorted to where infection was present. In view of the good results obtained, it must be questioned as to whether the open methods, advocated by the various authors, have a major place in the treatment of penile and peripenile haematoma. Although chronic cases mainly were available, the treatment I used is also applicable to cases seen soon after injury. In such cases ice or cold water application would be rational. If blood could be withdrawn by aseptic needle puncture some days after the haemorrhage, it would tend to limit formation of cicatrical tissues. The treatment advised by Metcalf[23] is imaginative and involves the injection of various drugs into the haematoma to liquify the clot, and subsequent removal thereof by insertion of a suction tube through an incision. It is considered that this method is applicable where a large, recently formed haematoma is present. The need to overcome the previously mentioned deleterious effects of a large haematoma overrides the disadvantage of traversing skin and all fascial layers by the incision and thus running the risk of causing adhesions directly between skin and haematoma. Metcalf's treatment may be contra-indicated in smaller lesions, unless full aseptic precautions are taken when withdrawing the contents of a liquified blood clot.

When infection is present and pus has not been discharged (either through the skin or through the preputial orifice), the surgeon has no option but to open the abscess when it is ripe. It is important not to make the skin incision any longer than is absolutely necessary. Massage must be started at an early stage before maturation of the scar tissue.

Mobilisation of the adhering structures has received very little attention in the literature, apart from what has been done regarding local operation or use of drugs and the recommendation of placing the bull amongst females in order to promote attempts at service. Purposeful routine massaging apparently has not been described at all but is most rational since it imitates the sliding movements of the fascial layers which occur during erection. During 10–20 minutes of massage the fascial layers get more movement than would occur during a dozen or more attempted services, even where the penis is fairly free. It must therefore be regarded as an eminently physiological treatment and is applicable even in cases where the penis is firmly tied down by scar tissue. It should be instituted whenever the affected tissues are in a condition to permit such handling. The good results obtained testify to this.

With massage no progress may be detectable for many weeks, then suddenly the penis can protrude spontaneously. The first erections are usually not entirely free, but from this point onwards improvement is rapid and normal erections occur within a few days or, more often, within one to two weeks.

Hot water is applied to the prepuce in order to promote hyperaemia and cause relaxation of the bathed tissues, the latter facilitating massage. Instillation of acriflavine-glycerine into the prepuce usually has no decisive effects. However, if erection is impossible, it does serve by its cleansing and disinfectant action to counter irritation that may be produced by the accumulation of urine-soaked smegma.

Finally, a note about inevitable incision of the preputial skin to divide a band of adhesion. The resultant cavity should not be sutured because this causes a definite reconstitution of a band of fibrous tissue. The cavity is sprayed with antibiotic in order to prevent local abscess formation, should infection enter. It fills up with serous fluid which may be slightly sanguineous, provided haemostasis has been attended to properly. Massage afterwards helps to disperse this seroma and healing takes place with a minimum of scar tissue formation.

As the injuries under discussion here in many instances appear to be due to faulty copulation practices by the bull, there is a great risk of sustaining the same type of injury again should the bull persist with this type of mating practice. Where fibrous tissue is adherent to the penis after successful treatment, this penile thickening would be more susceptible to bruising than a penis of even thickness.

Evaluation.

Ten of the 47 bulls failed to respond satisfactorily to treatment; four of these were treated by massage. In one case failure was conceded after a month but, as has been shown subsequently, there has been a dramatic improvement in cases carrying an unfavourable prognosis where treatment was prolonged, e.g. 2–3 months. One of these four bulls was seen once only on a distant farm. The animal had a large haematoma and abscess at the base of the scrotum with pus discharging from the preputial orifice through a sinus tract. The third failure had been bitten by a snake (probably a puff-adder) on the prepuce. As the venom of this snake, *Bitis arietans*, contains proteolytic and dispersing enzymes, severe inflammation and adhesions were present over the full distance between the scrotum and *fornix praeputii*. The remaining bull which failed to recover after massage had dip dysplasia and was destroyed at the owner's request even though good progress attended the treatment of the adhesions. Failure was assumed for statistical purposes, since recovery could not be proved.

Seven cases were not massaged and of these only one recovered. This bull showed a rather unusual feature, namely a sheet of dense fibrous tissue under the skin over the penis, apparently caused by tick bites. This precluded effective massage. On being exposed to cows in season he regained function of the penis after a few months. The bulls which were not massaged were amongst the first of this series to be studied.

It is concluded thus that massage offers an effective, physiological treatment of adhesions to the penis in the region between the scrotum and the *fornix praeputii*.

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Jl S. Afr. vet. med. Ass. 38 (4): 407-413 (1967)

AN OUTBREAK OF ATYPICAL INTERSTITIAL PNEUMONIA OF CATTLE

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SUMMARY

An outbreak of 18 cases of atypical interstitial pneumonia involving 10 deaths amongst young cross bred beef cattle on a large intensive irrigation farm is reported.

The history, symptomatology, pathology, treatment, control measures and special diagnostic procedures are described. Attempts at experimental reproduction of the disease condition are discussed. This is believed to be the first report of this disease complex in South Africa.

INTRODUCTION

Atypical interstitial pneumonia is known also as acute pulmonary emphysema of cattle, 'fog fever' and bovine pulmonary adenomatosis. This disease syndrome has been recorded fairly commonly in the northern hemisphere, especially in the U.S.A.,[1,2,3] Canada,[4,5,6] Europe[7,8,9,10] and Great Britain[11,12,13]. Clinically and pathologically acute and chronic forms of the disease are recognised[6].

The disease occurs primarily in the late summer and autumn, with sudden onset. It is characterised clinically by severe respiratory embarrassment. In the acute form the main pathological lesions are pulmonary emphysema and oedema with exudation into the alveoli of a protein rich fluid and the formation of hyaline membranes. The chronic form is characterised by epithelialisation of the alveolar lining and fibrous thickening of the alveolar septa.

The aetiology of atypical interstitail pneumonia is not clear. Various probable causes are listed in the literature:—massive infestation by lungworm larvae in sensitized animals[14], the inhalation of nitrogen dioxide gas[1], pasturing on rape and turnip tops[15], the ingestion of algae and the inhalation or ingestion of moulds[16]. The high incidence of the disease in autumn in the northern hemisphere when many plants are in flower suggests that the inhalation of pollen may play a causative role[6]. In Canada dust inhalation by stabled cattle is considered an important cause[6]. A nutritional deficiency of phosphorus and *Clostridium perfringens* intoxication[4] have also been suggested as causes of the disease. Outbreaks frequently follow a change in diet[6].

Beef and dairy cattle seem to be equally susceptible. The disease is more common in adults, being observed chiefly in animals older than six months. In the acute form breathing is accelerated and laboured with the head extended and the tongue protruded. A marked expiratory grunt is often present. The body temperature is frequently raised which apparently can be accounted for by reduced pulmonary heat exchange. The heart rate may vary from 80 to 150 per minute, being more than 120 in the terminal stage.

The chronic form is more insidious in onset, produces an increased rate and depth of respiration, an elevated heart rate and temperature and is often complicated by secondary bacterial pneumonia.

HISTORY

The oubreak occurred during late April 1967 in a herd of 509 weaner calves on a cattle breeding and fattening scheme operated in conjuction with sewage and waste water purification by the City Council of Johannesburg. The farm has an area of 2,800 morgen and at the time of the outbreak had a cattle population of 3,838 head.

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Paper read at 62nd Congress of the South African Veterinary Medical Association, Oct. 2-6, 1967.

Zero grazing was practised up to the age of 12 months. The calves remained in a six acre sleeping camp whilst their dams went out to pasture. A creep feed ration consisting of milled lucerne, eragrostis hay and sorghum husks (the residue after bantu beer manufacture) was fed. Hybrid sorghum silage was added initially to this ration for a short period. No silage was fed, however, for the last 3 months before weaning. The total digestable nutrients (T.D.N.) of the ration was gradually increased. The calf crop in question was weaned on the 3rd April at an average age of 7 months (variation 6–8 months). They were moved to a different 6 acre camp and the T.D.N. level of their ration increased from 6.5 lbs to 8.5 lbs. Maize silage was added to the ingredients of the abovementioned ration at this stage.

During the week of the 24th April to the 1st May there were ten peracute deaths. Of these animals three were not seen to be ill, five died within 12 hours of becoming ill and the other two died within 2 days. In addition there were a further eight non-fatal cases.

Investigation after the first death revealed both the eragrostis hay and maize silage to be infected with a variety of moulds. High rainfall and humidity of the second half of summer created ideal conditions for fungal infection of the open stacks of baled hay and flooding of the trench silo. In attempts to alleviate the flooding the silage became aerated with subsequent mould development. The affected silage was withdrawn on the second day of the outbreak and good quality, apparently fungus-free, silage substituted. The cleanest available hay was fed from the second day but this was still slightly mouldy and freshly baled hay was used from the 4th day after the start of the outbreak.

In addition the animals were moved to another camp but had to spend a few hours per day in the original camp for feeding and watering. A tetracycline feed additive* was fed to the entire herd from the 6th day after the first deaths. On that day the milled lucerne was withdrawn because it was dustry and had been cut in an advanced flowering stage. The excessive dust was due to the lucerne having been milled instead of chaffed as was the normal procedure.

*T.M. 10 Pfizer.

Symptoms

The first indication of the disease outbreak was the peracute death of one weaner about two hours after feeding. Observation of the herd revealed another animal to be acutely ill, showing marked dyspnoea and a temperature of 105.6°F. It was treated provisionally with a tetracycline and a pirocidal drug† before either the examination of a blood smear or the autopsy on the dead animal had been performed. The animal was so severely affected that it was unable to rise and death followed quickly.

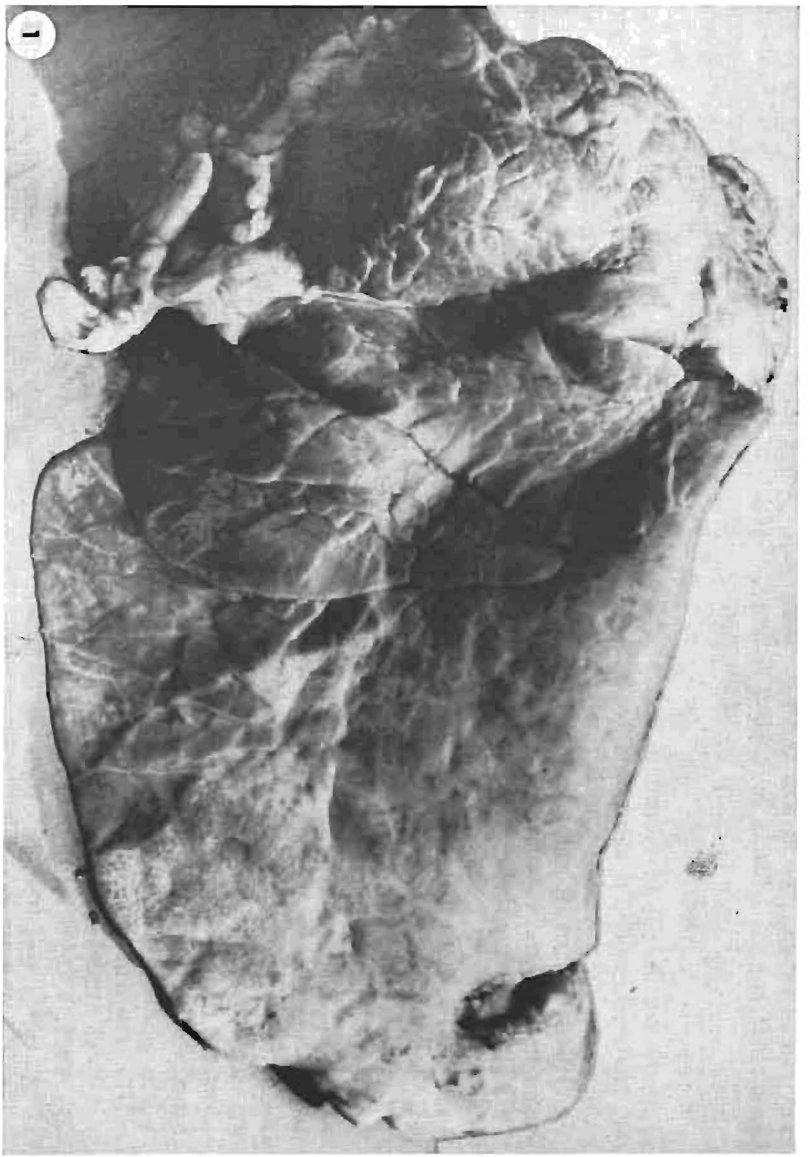
The typical clinical picture was one of sudden onset and marked respiratory distress (accelerated, laboured breathing) together with pyrexia. The severe cases held their heads outstretched and breathing was of a panting nature, shallow, rapid and abdominal. Respiration rates varied from 80 to 126 per minute and on auscultation loud bronchial tones were evident over the ventral parts of the lungs. Body temperatures varied from 103.8 to 107°F. Heart rates were so markedly increased that it was difficult to record the actual rate per minute. The heart sounds were also masked by the respiratory sounds. One animal had a marked expiratory grunt (80/min.) accompanied by mild frothing at the mouth. Cyanosis was observed in all cases, being most marked in the more severely affected animals. Ruminal atony was present in all cases.

Four of the eight cases which recovered showed similar symptoms to the fatal cases. The other four were less acutely ill and, although abnormal pulmonary sounds were heard, they did not show such severe dyspnoea.

Treatment of affected Animals

From the second day of the outbreak all animals showing symptoms were treated with an antihistamine* combined with tetracycline hydrochloride**. On the 4th day a corticosteroid*** was introduced and the antihista-

†Gonacrine (M & B).
*Phenergan (M & B).
**Ultramycin (Millborrow).
***Vecortenol (Ciba).



mine**** changed. In the cases that survived, antihistamine and various antibiotics were used until respiration and temperatures returned to normal. The progress of the affected animals varied, some starting to eat the day after treatment was instituted and the most severely affected ones (No's. 6, 8 and 11, Table I) only after four or five days.

haemagglutination inhibition test against parainfluenza 3 virus. These serum samples were taken from six clinically sick animals, three apparently healthy animals and one chronically ill runt.

Specimens of the mould-infected eragrostis hay and maize silage were collected for identification of the various fungi.

TABLE I.

Animal	When first observed	Death	Initial Temp. °F	Age	Clinical Picture	Post Mortem
1	not	24/4/67	—	7½ mths		Typical
2	24/4/67 (2.30 pm).....	Evening of 24/4/67	105.6	8 mths	Typical	,,
3	25/4/67 (3.30 pm).....	Evening of 25/5/67	106.8	8 mths	,,	,,
4	,, ,, ,, ...	,, ,, ,,	105.6	8 mths	,,	,,
5	26/4/67 ± 2 pm.....	Evening of 27/4/67	T.107	8 mths	,,	,,
6	26/4/67 ,, ...	—	T.106.2	8 mths	,,	—
7	26/4/67 ,, ...	Evening of 26/4/67	T.106	6 mths	,,	Typical
8	27/4/67 ± 2.30 pm.....	—	T.104.4	8 mths	Typical	—
9	27/4/67 ,, ...	Evening of 27/4/67	T.105.8	6 mths	,,	Typical
10	28/4/67.....	Evening of 29/4/67	T.107	7 mths	,,	,,
11	28/4/67.....	—	T.105	7 mths	,,	—
12	,, ...	—	T.103	6 mths	Atypical	—
13	30/4/67 (10.30 am).....	—	T.103.8	7 mths	Typical	—
14	—	Evening of 30/4/67	—	8 mths	—	Atypical
15	—	,,	—	7½ mths	—	Atypical
16	2/5/67.....	—	T.105.4	7 mths	Atypical	—
17	2/5/67.....	—	T.104.0	6 mths	Atypical	—
18	3/5/67.....	—	T.104.2	6 mths	Atypical	—

Diagnostic Procedures

Autopsies were performed on the ten animals that died. Specimens from various organs, including several from each lung, were collected and fixed in 10% buffered formalin for histopathological examination. The recovered cases were slaughtered 3½ months later and lung specimens collected for histopathological examination.

Specimens from various organs including lung were collected for bacteriological and virological examination from some of the animals that died.

Ten serum samples were collected for the

The following feeding trials were conducted:—

1. Fungus-infected eragrostis hay and maize silage collected at the time of the outbreak were fed to a bovine at the Veterinary Research Laboratory at Onderstepoort.

2. Lucerne, cut at the normal flowering stage (1/10th) was fed to 35 and later to 105 of the unaffected animals. This was done six weeks after the outbreak.

3. The original milled lucerne, cut at an advanced flowering stage and fed at the time of the outbreak, was fed to the eight recovered animals. Initially all eight were fed from an open air trough but later two were stabled in a

****Vetibenzamine (Ciba).

small room in order to accentuate the dust factor.

4. Two weeks after the commencement of the third feeding trial, mouldy eragrostis hay was added to the lucerne fed to the six animals in open air troughs and to the two that were stabled.

5. After a further 2 weeks mouldy maize silage from the same silo that was used at the time of the outbreak was added to the ration of the two animals confined in the small stable. Only a small amount of this silage was found adherent to the sides of the unlined silo. It was consequently contaminated by soil and very unpalatable; difficulty was experienced in getting the animals to eat it, despite virtual complete withdrawal of other feedstuffs.

Feeding trials 2, 3, 4 and 5 were conducted on the farm.

Specimens of the hay and silage used in the above trials were taken in order to compare the fungus populations at this stage with those at the time of the outbreak.

Results

Pathology

Gross Lesions

The most striking changes at autopsy were confined to the lungs. They were distended and exhibited a mottled appearance caused by light pink raised areas of emphysema, light yellow oedematous areas and firm dark red areas alternating with normal lung tissue. The emphysema was both alveolar and interstitial in nature, often forming bullae of varying size (Fig. 2) in the interlobular septa, sub-pleurally and around the larger bloodvessels. The emphysema was most marked in the dorsal parts of the diaphragmatic lobes, while the ventral parts of the anterior lobes were dark red with a flesh-like consistency (Fig. 1). The lung tissue was easily incised and friable. Large amounts of blood-stained fluid oozed from cut surfaces and the interlobular septa were markedly distended by air or oedematous fluid. In the trachea and bronchi large quantities of white froth and oedematous fluid were seen. Focal petechial haemorrhages, sometimes very numerous, were present in the mucous membranes of the air passages, especially the trachea. Small amounts of free blood were noticed in the air passages of some of the cases.

Emphysema of the mediastinum was a common observation. The bronchial and mediastinal lymph glands were enlarged, oedematous and frequently emphysematous (Fig. 3) with small focal haemorrhages.

All carcases showed marked general congestion and cyanosis. Numerous sub-epi- and sub-endocardial haemorrhages were present. Varying degrees of congestion of the whole digestive tract were seen in most cases.

The last two cases varied somewhat from the first eight cases in that the lungs were less severely affected and congestion of the digestive tract more pronounced with focal petechial haemorrhages in the mucosa of the intestine.

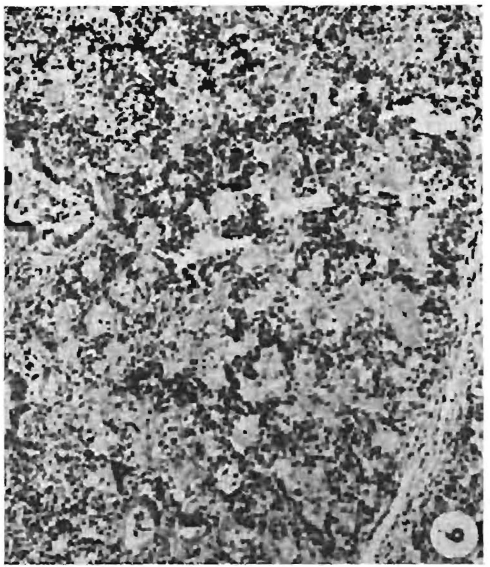
No lesions were observed in the lungs or in any other part of the carcases of the eight recovered animals which were slaughtered.

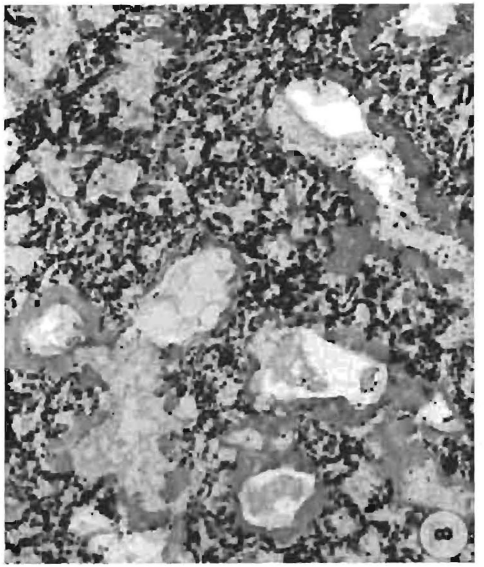
Microscopic Lesions.

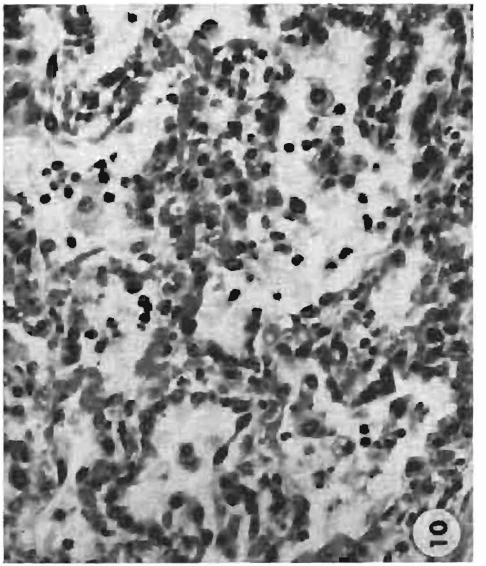
Histologically the lesions in the lungs varied from areas of emphysema, areas of oedema with intense congestion (Fig. 6), areas where alveoli were filled with a fibrinous exudate, and epithelialisation of the alveolar epithelium (Fig. 10). In most cases the interlobular septa were extensively distended by air bubbles and by a pink staining serous exudate (Fig. 5 & 7). Similar changes were also observed subpleurally. Alveolar emphysema of varying degree was present in all the cases. In some instances marked emphysema was seen around larger blood vessels (Fig. 4). Marked engorgement of capillaries was evident and some alveoli contained free erythrocytes.

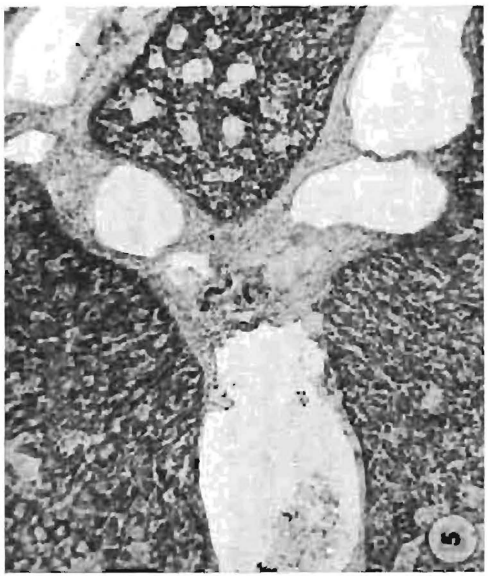
Many alveoli were filled with a fibrin-rich exudate which often was coagulated into irregular hyaline masses or drawn out into hyaline 'membranes' which lined the alveoli and alveolar ducts (Fig. 8). A moderate infiltration of polymorphonuclear cells was present in the alveoli and in the septal spaces. Many of these cells were eosinophiles and in some cases this cell type was fairly prominent. Varying numbers of alveolar macrophages were also present in the alveoli (Fig. 9). Alveoli adjacent to those containing the serous exudate were often collapsed. Cuboidal epithelialisation of the alveolar epithelium was never extensive, being patchy in distribution.

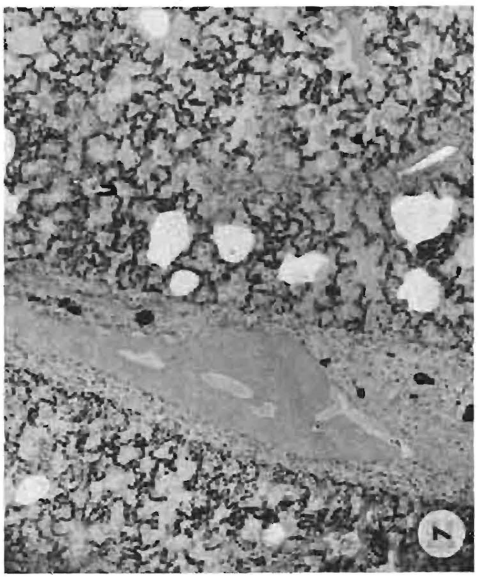
The mediastinal and bronchial lymph nodes were oedematous. Large air bubbles were

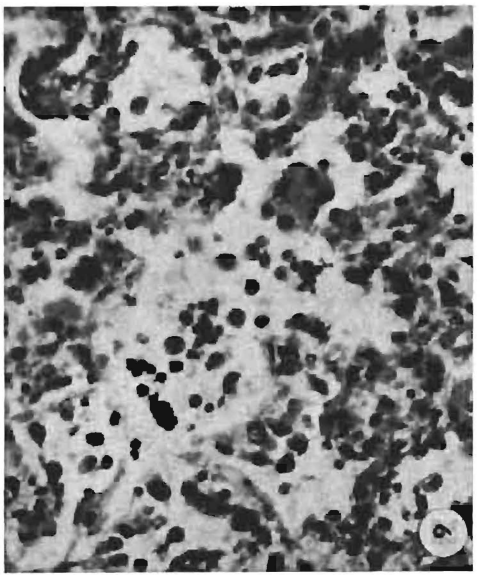












present in the medulla as well as small focal haemorrhages. Centrilobular degeneration was seen in the livers. Degeneration and passive congestion of varying degrees were also present in other parenchymatous organs. Congestion was sometimes marked in the mucosa of the intestinal tract in which small haemorrhages were also seen.

Bacteriological Examination

Pasteurella haemolytica was isolated from the liver in one case and *P. multocida* from the lungs of another.

Virological Examination

Organ specimens, including lung from three weaners and blood from two sick animals were examined. No virus could be isolated on baby hamster kidney ($BHK_{21}C_{13}$) and rhesus monkey kidney (LLC—MK_2) line cells or on primary cultures of lamb and calf kidney cells. Various attempts at isolation were made, including blind passages.

Serum Samples

The 10 serum samples were tested against para-influenza 3 virus in the haemagglutination-inhibition test. All were negative except one which had an H.I. titre of 1:160. This animal was one of the group of apparently healthy animals. It can therefore be concluded that para-influenza 3 virus played no aetiological rôle in the disease condition.

Identification of Fungi on Mould Infected Silage and Hay

The following fungi were isolated from the eragrostis hay and maize silage specimens taken at the time of the outbreak.

(*a*) *Eragrostis hay*: *Humicola stellata*, *Helminthosporium* sp., *Cladosporium* sp., *Aspergillus* spp., *Penicillium* spp. and *Chaetomium* sp. *Humicola stellata* was abundant in the centres of the bales which were in various stages of decomposition.

(*b*) *Maize silage*: *Monilia* sp., *Fusarium* sp., *Rhizopus* sp., *Mucor* spp. and *Penicillium* spp. *Monilia*, *Rhizopus* and *Mucor* spp. flourish in moist humid conditions. *Monilia* sp. was very abundant.

(*c*) *Soil-contaminated maize silage with which the one feeding trial was conducted.*

The following fungi were present: *Penicillium* sp., *Cladosporium* sp., *Hormodendrum* sp. and *Monilia* sp., the latter was virtually absent, characteristic of dry conditions.

(*d*) *Hay with which feeding trial was conducted*: *Penicillium* spp., *Aspergillus* spp., *Hormodendrum* sp., *Rhizopus* sp and *Alternaria tenuis*.

Feeding trials.

None of the animals died or developed any untoward reactions.

Discussion

The clinical picture, the gross pathology and the microscopic lesions of the cases reported here are identical to the findings recorded in previous reports[4,5,6,9,13] of the acute form of atypical interstitial pneumonia of cattle. To our knowledge this disease complex has never previously been reported in South Africa.

In view of the many causal factors that have been incriminated, it seems doubtful whether this particular pulmonary syndrome can be regarded as a specific disease with a single specific aetiological agent. It has been suggested that the pulmonary lesions seen in atypical interstitial pneumonia of bovines are of the nature of an allergy or histamine reaction. Various materials have been suggested as allergens that may cause the disease when ingested or inhaled by the animal.

Experimentally a similar syndrome has been produced with *Dictyocaulus viviparus*[14]. On the basis of these results it was suggested that the syndrome could be an effect of a hypersensitivity reaction similar to the so-called 'self cure' phenomenon, observed in some forms of intestinal parasitic infections. No lungworms were observed in the lungs at autopsy of any of the cases we examined. Histological examination of the lungs revealed no helminth parasites. Examination of the lungs of the eight recovered cases slaughtered $3\frac{1}{2}$ months after the outbreak proved negative for lung-worms.

The close morphologic resemblance between 'silo-filler's disease' in man, which is the result of inhalation of nitrogen dioxide,[17] and atypical interstitial pneumonia of bovines has been pointed out. Seaton[1] succeeded in producing lesions experimentally similar to atypical interstitial pneumonia by nitrogen dioxide inhalation in cattle. That significant amounts of nitrogen dioxide will be inhaled by cattle feeding on silage from open air troughs, as was the case in the herd under discussion, seems remote.

According to Blood[6], stabled animals in Canada standing near the hay chute from which hay and bedding are thrown down from the mow to the barn floor, often develop the disease. This selective occurrence of the disease within a stable may be connected to the fact that these animals are more exposed to hay dust than the others. The high incidence of the disease in early autumn in the northern hemisphere has lead to the suggestion that inhalation of pollen may cause an allergic response of the alveolar epithelium[6]. The milled lucerne that was fed to the weaners was very dusty and was cut at an advanced flowering stage. Both pollen and dust might have been incriminated in this instance and feeding trial 3 was therefore conducted. Feeding trial 2 was conducted as it was thought that the allergen may have been connected with the lucerne due to the fact that no further cases were observed from the day when the lucerne was withdrawn. The eight animals used were chosen as it was considered that they were the most likely to be sensitised having previously received the lucerne and having shown symptoms. The results were negative, indicating that neither lucerne, dust, nor pollen played a rôle.

Mouldy feeds have been implicated as possible allergens[16]. Feeding trials 4 and 5 were conducted to investigate the possible rôle that the fungus infected silage and hay might have played as aetiological agents. Results were negative again. The variation in fungus population, probably due to decrease in moisture of the silage and hay, and the limited quantity available for test feeding are possibly significant in the failure to reproduce the condition. Despite the negative results obtained, it is felt that the fungus infected silage may have played the major aetiological rôle. Abnormal wet and humid conditions plus aeration of the silo by the digging of holes for drainage purposes created ideal conditions for excessively heavy infection of the silage by fungi.

Jenkins and Pepys[19] presented evidence that serum from cases of 'fog fever' contained antibodies to the fungus *Thermopolyspora polyspora*. They also demonstrated antibodies to this fungus in cases of 'farmers lung' in man, suggesting that the 'fog fever' syndrome in cattle may have a similar aetiology to 'farmers lung' in man.

Recently Dickinson *et al*[18] reported the reproduction of an acute respiratory syndrome in cattle by administration of large oral doses of DL-tryptophan. The onset, course, clinical signs and pulmonary lesions of this experimentally produced condition were strikingly similar to those observed in atypical interstitial pneumonia of cattle. The relationship between this experimental disease and the naturally occurring syndrome is not clear. The authors point out, however, that the natural disease is often observed following a change in forage, while the experimental disease is induced by a sudden overload of a naturally occurring dietary constituent. It is possibly significant, therefore, that the addition of the fungus-infected maize silage to the ration was the only change in feeding and that 21 days elapsed between the introduction of the silage and the occurrence of the first deaths.

An interesting point is the age group of the affected animals (6–8 months). Some authors[6] state that the incidence is very much higher in older mature animals. Omar and Kinch[13], however, reported the occurrence of the disease on 11 farms in Britain, in calves from 2 to 6 months old. At the time of the outbreak reported here, other older animals were being fed on the same feeds, viz. mouldy hay and silage from the aerated silo face with no untoward effects. This could have been due to the fact that the weaners had been weaned only three weeks earlier and may have been exposed to heavier fungus concentrations due to the patchy distribution of the fungus on the silage.

The isolation of a pasteurella from the lungs of some of the cases is not regarded as significant. It is a common inhabitant of the upper respiratory tract of cattle. No evidence was present histologically that this organism was involved in the reaction in the lung tissue. The reaction of the pulmonary tissue in this condition differs from that of the usual forms of pneumonia in cattle. The marked and sudden accumulation of a protein-rich fluid in the alveoli throughout large parts of the lung and the almost total absence of any cell reaction, except for eosinophiles and macrophages, point to an allergic reaction.

According to Blood[6], acute cases must be treated as urgent and, although no controlled experiments have been carried out, good results

have been achieved in very early cases with the administration of combined double doses of adrenaline and antihistamine, both being given subcutaneously to avoid excitement and being repeated at 8 hourly intervals as required. However, antihistamines combined with corticosteroids and antibiotics used in this outbreak appear to have been beneficial. Chronic cases usually present irreversible tissue damage and the wisest policy appears to be to advise slaughter[6]. Control measures are dependent upon a knowledge of the cause, and contact with all suspicious aetiological agents should be removed.

Acknowledgement

The authors wish to thank the following persons who contributed in many ways to make this report possible; Prof. T. F. Adelaar and Mr. K. T. van Warmelo, Department of Toxicology, Onderstepoort, Prof. K. van der Walt, Dept. of Medicine, Dr. R. W. Muir and Dr. H. J. W. Botes, Dept. of Bacteriology, Dr. B. J. Erasmus, Dept. of Virology, the technical staff, Dept. of Pathology, Mr. A. M. du Bruyn and staff, Section Photography and the personnel on the Johannesburg City Council farm.

The City Engineer, the Director, Abattoir and Livestock Market Dept., City Council of Johannesburg and the Chief Veterinary Research Institute, Onderstepoort are thanked for their permission to publish this report.

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Jl S. Afr. vet. med. Ass. 38 (4): 415-419 (1967)

ENZOOTIC PNEUMONIA OF SHEEP IN THE MAFEKING DISTRICT

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SUMMARY

In two years more than 400 sheep died on 36 farms in the Mafeking district. *Pasteurella haemolytica* and/or *Pasteurella multocida* was isolated from sheep in 17 of these outbreaks. Specific experimental vaccines prepared at the Veterinary Research Institute, Onderstepoort were the only means of control. The symptomatology, pathology and merits of different methods of control are discussed.

INTRODUCTION

A respiratory disease, associated with *Pasreurella* infection, first investigated in the Mafeking district by Buhr and Zumpt[1], caused the death of a large number of sheep in that area during the years 1964–1965. They found that sheep of all ages and breeds were susceptible, with the highest incidence in those subjected to stress, such as pregnancy, malnutrition and verminosis.

In 1936 Henning and Brown[2] studied a very virulent outbreak of fibrinous pleuro-pneumonia in sheep in which a pasteurella was implicated. Pasteurella had already been associated with pneumonic conditions in calves by Nocard and Mettam[3] as early as 1901.

Stamp, Watt and Tomlinson[4] described a disease in lambs, similar to that dealt with in this article, from which they isolated *P. haemolytica*, and mentioned the probable rôle played by stress and environmental factors. Dungworth[5] described a similar condition and called it "Enzoötic Ovine Pneumonia". Dungall[6] isolated *P. haemolytica* from sheep and cattle suffering from infectious pneumonia and reproduced the disease in sheep by the intratracheal instillation of cultures of this microbe. He controlled the disease successfully by vaccination and mentioned the importance of stress factors. Smith[7] was also able to reproduce the disease by intra-bronchial instillation of a culture of *P. haemolytica type A* and he, too, mentioned the rôle of stress. Henning[8] and Carter[9] give fairly comprehensive reviews of the literature dealing with this condition.

INCIDENCE

No clear seasonal incidence could be established, although *P. haemolytica* and *P. multocida* were isolated more frequently from August to January than in the remaining months of the year. Further to Buhr and Zumpt's findings it was found that dosing and handling of sheep, long treks and dusty feeds also precipitated the disease. The latter playing a very important rôle where sheep were kept in feeding kraals.

MATERIAL AND METHODS

The scene of each outbreak was visited in order to study the epizootiology and to take samples for bacteriological examination. Initially, samples of lung and nasal exudate were taken from sheep that had died on the day of the visit but, as growth of contaminants rendered the results unsatisfactory, the following procedure was adopted. One or two sheep suffering from mild dyspnoea and nasal discharge were selected, killed and samples of lung and/or nasal septum taken with sterile instruments and placed in sterile containers. These in turn were immediately placed on ice and sent to the Veterinary Research Institute, Onderstepoort.

A detailed *post mortem* examination was done and the results recorded. An autogenous vaccine containing killed suspensions of either *P. haemolytica*, *P. multocida* or both was prepared at Onderstepoort from organisms isolated from

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the specimens. A group of sheep in the specific flock was immunised, the rest acting as controls.

In all, 5,055 sheep on 11 farms were immunised with 2 x 5ml injections of vaccine with an interval of 4 weeks between injections. Sheep in adequate numbers on each farm were not immunised and served as controls.

Symptomatology

A pulmonary and head form of the disease occurred.

1. Pulmonary Form

(*a*) *Acute*: This form was seen in 1–2% of cases. Temperature 105—106°, slight dyspnoea, lachrymation, and listlessness followed by death within 24–96 hours.

(*b*) *Subacute*: Temperature 104°F, dyspnoea and lachrymation, followed by coughing, sneezing, stiffness in the fore-quarters, generalised lymphadenitis and sero-mucous, later muco-purulent, nasal discharge. Rapid loss of weight was then followed by death in 10% to 15% of affected sheep within the first two weeks, the rest becoming chronic.

(*c*) *Chronic*: Severe pneumonic symptoms characterised this form. A small percentage died 4 to 8 weeks after symptoms were first noticed, probably from secondary complications. The remaining sheep were all affected in varying degrees. In most cases a break in the wool or a patchy loss of wool was noticed as also a severe loss of weight. Recovery was always slow and the unaffected sheep outgrew the affected ones.

2. Cephalic Form

This form was found only in chronic cases and occurred mainly in sheep in good condition. Marked dyspnoea, sneezing and purulent nasal discharge was followed by abscessation of the lips, cheeks, nasal bones and nostrils. The diameter of these abscesses varied from that of a pinpoint to 5cm; some burst spontaneously and released a thick yellow pus. Necrosis of the epidermis with sloughing and/or the formation of sitfasts, and oedema of the soft tissues of the head were seen. Some animals were affected to such an extent that they could not eat. Emaciation was usually followed by death. Death in untreated sheep decreased progressively over a period of weeks, indicating that the disease is self-limiting.

Pathology

Although the lesions of pasteurellosis are varied and non-specific, an attempt was made to group them.

1. Pulmonary Form

(*a*) *Acute*: Hyperaemia, inter-lobular oedema and emphysema of the lungs, tumour splenis, tumour hepatis and generalised hyperaemia, as well as sub-epicardial haemorrhages along the course of the cardiac vessels, and sub-endocardial petechiation were all typical of this form.

(*b*) *Subacute*: In addition to the above pulmonary changes, areas of consolidation from 0.5 cm to 3 cm in diameter were present in the apical and cardiac lobes. Foam in the bronchi and trachea was a constant finding. Generalised fatty changes of the liver, nephrosis, atrophy of the spleen, and petechiae on the endocardium and epicardium and on all serous surfaces were also seen.

(*c*) *Chronic*: A purulent broncho-pneumonia was followed by a fibrino-purulent broncho-pneumonia with secondary abscesses in the lung and, in advanced cases, adhesions of the lung to the ribs. Atrophy of the spleen, fatty liver changes, nephrosis, serous atrophy of the fat and a generalised congestion of all blood vessels were seen. Histologically a fibrino-purulent broncho-pneumonia was usually found and alveoli in consolidated areas were filled with round cells, cell debris, and fibrin. Proliferation of peribronchial lymphoid tissue and bronchial epithelium was sometimes present. In smears made from the affected lungs of some sheep, short Gram-negative bacteria with typical bipolar staining properties were seen.

2. Cephalic Form

Oedema and hyperaemia of the turbinate bones and nasal septum, with petechiae and

TABLE 1.

SUMMARY OF POST-MORTEM FINDINGS IN 23 SHEEP

Sheep	Hyperaemia oedema emphysema of lungs	Consolidation of lungs and adhesions	Inflammation of nasal mucosa and turbinates	Softening of turbinates	Liver: fatty changes	Nephrosis	Tumour splenis	Atrophy of spleen	Lymphadenitis	Abscessation of face and head	Skin necrosis	Petechiae of epicardium, endocardium and serous surfaces.
1	+	+	+		+							+
2	+	+			+							+
3	+	+				+						+
4	+	+			+	+						+
5	+	+			+						+	+
6	+					+						+
7	+	+										+
8	+	+			+	+	+					+
9	+	+										+
10	+	+	+					+		+		+
11	+		+	+				+	+	+		+
12	+						+	+	+			+
13	+	+										+
14	+	+						+		+		+
15		+	+									+
16	+	+	+	+				+	+	+		+
17	+	+										+
18	+	+						+				+
19	+	+										+
20	+	+			+			+				+
21	+	+										+
22	+	+						+	+	+		+
23	+	+	+		+			+	+	+		+
Cases %	22 95%	20 82%	6 26%	2 10%	7 30%	4 18%	2 10%	9 40%	5 20%	6 26%	1 5%	23 100%

ecchymoses especially near the cribriform plate. Small abscesses, 0.5 cm. in diameter, were scattered along the surface of the nasal passages and there was a copious seromucous exudate. In some sheep a generalised lymphadenitis was present. These lesions progressed in older cases to abscesses and necrotic foci in the turbinates and cribriform plate with prominent bulging of the nasal and facial bones, some abscesses breaking through these bones and forming purulent fistulae. In the later stages complete obstruction of the nasal cavities caused by connective tissue was seen. In some cases abscesses were found in the tongue, pharynx and all lymph nodes in the head region. In 50% of these cases the lungs were also chronically affected. Softening of turbinates and nasal septum was seen in a small percentage of cases. Areas of epidermal necrosis and sloughing with formation of sitfasts were seen on the skin of the head. At times this could be confused with photosensitisation.

Table 1 gives a summary of the more common necropsy findings.

TABLE 2
BACTERIAL ISOLATIONS

Microbe Isolated	Total Outbreaks	Lung form	Head form
1. *P. haemolytica*.....	11	9	2
2. *P. multocida*.....	4	2	2
3. *P. haemolytica*..... and *P. multocida*	2	1	1

From 11 sheep the following organisms were isolated in conjunction with either *P. haemolytica* or *P. multocida* or both:— a micrococcus, *Pseudomonas aeruginosa*, an achromobacter, *Corynebacterium pyogenes*, a streptococcus (∝-haemolytic), *Citrobacter freundii*, *Streptococcus bovis*, *Staphylococcus aureus* and *Alcaligenes faecalis*.

Isolation of *Myxovirus parainfluenzae* and *Mycoplasma* organisms from specimens sent from three outbreaks was unsuccessful.

CONTROL MEASURES

(*a*) *General*

Isolation of affected sheep did not prevent the spread of the disease. Treatment with tetracyclines and sulphonamides was disappointing and economically prohibitive.

No conclusion can be drawn from the use of Vitamin A as only one flock was treated, but it seemed to reduce the number of affected sheep.

(*b*) *Immunisation*

Initially there was no intention of conducting an immunisation experiment, thus only a general impression of the results of immunisation can be given.

In the immunised groups deaths due to pasteurellosis stopped within three to four weeks except on two farms where a few sheep died after this period. Losses in the immunised sheep were between 1% to 2% against 15% to 20% in the controls. Furthermore, the immunised ones were healthier and heavier than the non-immunised sheep which never 'caught up' with them.

DISCUSSION AND CONCLUSIONS

The isolation of *P. haemolytica* and *P. multocida* from 17 of 36 outbreaks indicates that this organism is primarily responsible for enzoötic pneumonia. It is possible that in those outbreaks where these bacteria could not be isolated, the pasteurella had been overgrown by other bacteria. Although the symptoms and *post mortem* findings are not specific, they, together with the history, form a pattern definite enough to warrant a diagnosis of the disease. Immunisation appears to play an advantageous rôle in the control of this disease. Even though it appears to be self-limiting our experience shows that the economic loss due to poor condition, morbidity and mortality is much greater in non-immunised than in immunised flocks, but more work will have to be done before any definite conclusion regarding immunisation can be drawn.

ACKNOWLEDGEMENTS

The Chief, Veterinary Field Services is thanked for permission to publish this article. Dr. C. M. Cameron of Onderstepoort is especially thanked for carrying out the bacteriological investigations and for preparing and providing the vaccine. Dr. J. H. Mason of the South African Institute for Medical Research is thanked for reading and correcting the manuscript and for his helpful criticism.

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Jl S. Afr. vet. med. Ass. 38 (4): 420-424 (1967)

POST-DIPPING LAMENESS (LAMINITIS) IN SHEEP AND GOATS IN SOUTH AFRICA

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SUMMARY

Two outbreaks of post-dipping lameness involving sheep and goats are reported. *Erysipelothrix insidiosa* (Trevisan 1885) was isolated from the dip wash in one instance and from mud around the dip in the other. Although the organism was not isolated from affected animals, it is considered that its isolation from the dip wash, the history of the outbreaks and the similarity of the symptoms to those described in the literature constitute strong circumstantial evidence incriminating this organism as the cause of the condition. Prevention by the addition of anti-bacterial agents to dip washes is advised.

INTRODUCTION

McLean[1] first reported post-dipping lameness, and the condition was then thoroughly investigated, in New Zealand by Whitten, Harbour and Allan.[2]

Cole[3] recognised the condition in Australia, de Diego[4] in Argentina, Ault and de Diego[5] in Chile and Uruguay and Harbour & Kershaw[7] in England. Ault and de Diego[8] reported its wide incidence throughout South America. In all these cases, the affected sheep were dipped in previously used washes that had been standing for some time. To date this condition has not been reported from South Africa.

Whitten *et al*[2] and later Gill[9] isolated *Erysipelothrix insidiosa* from affected sheep and the stale dipwashes concerned. Whitten [10] met a similar condition in some ewes but it was not associated with dipping, although post-dipping lameness had previously occurred on the same farm. From some of these cases he also isolated *Corynebacterium pyogenes*.

McLean[1] reported that he had encountered typical post-dipping lameness in 1941 while testing a Derris powder dip (*Derris elliptica*) but at that time the cause had not been elucidated. The paper by Whitten *et al*[2] concerned outbreaks in sheep dipped in a non-phenolic benzene hexachloride suspension. Harbour *et al*[11] met the condition in sheep which had been dipped in a DDT/BHC wash, whilst Cole's[3] investigations were on sheep dipped in "Gammazene" (BHC).

A search of the literature has revealed only one report, by Allan, (in the discussions on McLean's[1] paper) of post-dipping lameness occurring after dipping in a wash containing arsenic. No lameness has been reported in sheep dipped in phenolic washes.

The disease syndrome has been well described[1,2,3,9]. The second authors emphasized that it was very similar to "erysipeloid of Rosenbach" of man.

Sheep dipped in freshly made up washes do not develop post-dipping lameness but this is apt to occur when sheep are dipped in stale non-phenolic and non-arsenical wash, without a bacteriocide, which has been previously used and allowed to stand for some time[1,2,3,9,12]. The multiplication of *E. insidiosa* in standing used wash can be suppressed by the addition of copper sulphate (4 lb per 1000 gallons)[2]. Ault and de Diego[12] remarked: "The addition of a phenolic dip or copper sulphate to the wash prevents the disease". The incidence in flocks varies greatly, and can be as high as 80%, the lameness setting in two to four days after dipping. Sheep are usually lame in one limb, but occasionally in more legs. In the majority of animals recovery is complete within one to three weeks.

The affected coronet in lame sheep is hot and

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swollen, and the oedema may extend up the cannon bone. There is depilation of the affected area in many recovering sheep. *Post mortem* examination reveals only an erythema and a slight excess of fluid in the subcutaneous tissues. Whitten *et al*[2], Cole[3] and Whitten[10] successfully isolated *E. insidiosa* on blood agar after preliminary enrichment of the donor material from the lesions in a broth medium and the last used a sodium azide crystal violet broth as described by Packer[13].

Although the organism was shown to be susceptible to penicillin by Barbour, Nellen and Zoob[14], treatment of affected sheep with penicillin does not appear to influence the course of this ephemeral condition, as natural recovery is rapid and complete in the majority of affected sheep[2]. Woodbine[15] studied *E. insidiosa* fully. Blood and Henderson[16] give a useful and succinct description of this condition, and they favour the name "Post-dipping Laminitis".

Outbreak on farm 'A'

History

In 1963 a farmer in the Kendrew district dipped some 4000 sheep and 1000 goats in a miscible oil product based on dichlophenthion over a period of three days. Four days after the last dipping some lambs were brought into the homestead for vaccination and were found to be lame. Inspection of the flocks showed that some 90% of the animals were lame, there being a correlation between the incidence of lameness and the time of dipping, those flocks which were dipped on the first day being least affected and those dipped on he third day having the highest incidence.

The farm was visited ten days after the last dipping, and by then a large number of the animals had already recovered.

Symptoms

Over 60% of the sheep and goats seen showed varying degrees of lameness. Although the majority were lame in one leg only, many were lame in more than one limb; a few appeared to be "tender all round" with a "walking-on-eggs" gait.

Most of the affected limbs were thickened towards their distal extremities. This thickening was readily discernible particularly where only one of a pair of limbs was affected. A fair number (10–15%) of affected limbs did not show any thickening of the distal extremities, and this was particularly noticeable in the "tender all round" subjects.

All animals examined were infested with bont-legged ticks.

Closer examination of the thickened limbs revealed oedema which was confined to the extremities, i.e. from the coronet to the fetlock. The swollen parts were painful and hot. In several instances, limbs, other than those visibly affected, were hot and the animal enviced pain when pressure was applied to these areas. Several animals showing "walking-on-eggs" symptoms were examined; there was heat in all feet and frequently a slight puffiness of the coronet was discernible.

No evidence of suppuration, actual or incipient, was found. Even where the coronet was very puffy, the skin was clear and uninflamed. One animal showed red vertical "palisade" striations on the coronet not dissimilar to those sometimes seen in bluetongue.

Dipwash was collected from the tank and despatched to the Cooper Technical Bureau and a lame sheep was sent to the Veterinary Research Institute, Onderstepoort.

Outbreak on farm 'B'

History

A farmer on the foothills of the Drakensberg, in the district of Harrismith, dipped some 8000 sheep during December, 1966. The first day some 3700 sheep were dipped in a wash made up from a miscible oil based on chlorfenvinphos. The next day he dipped 4190 sheep in the same wash. The sheep were walked to the dipping tank from distances of up to four miles. Those from very distant camps were brought in the previous evening. On both days dipping was commenced at 5 a.m. and completed before midday. Four days after dipping he noted many lame sheep.

This outbreak was first investigated by the fourth author, who found that in some flocks as many as 80% of the sheep were lame. The farm was visited by the third and fourth authors on the 17th and 19th days after dipping.

During the second visit, it was learned that a neighbour (Farm C) had dipped 12000 sheep in a wash made from chlorfenvinphos miscible

oil. The first day 2000 sheep were dipped in one tank and none of them went lame. Ten thousand sheep were then dipped over a period of four days in another tank. None of the sheep dipped on the first or second days went lame, but up to 15% of the sheep which were dipped on the third and fourth days showed lameness. Several sheep lost the wool from their faces. One of these was submitted to Onderstepoort for examination. The distributor of the dip stated that this was the only outbreak he had been able to trace but added that many farmers, as a routine measure, add 4 lb copper sulphate for every 1000 gallons of wash in their tanks.

Symptoms

Examination of representative affected sheep showed that the temperature was normal in the majority, and in the few with a mild pyrexia the elevation did not exceed 1.5°F. The majority of affected sheep appeared to be lame in only one leg, but some were lame in two or three legs. Some sheep, although not lame, had an unusually stilted gait suggesting that they were sore in all legs. Examination of lame sheep revealed a hot oedematous area around the hoofs sometimes extending upwards for 5 inches above the coronary band. Enquiry revealed that few, if any, sheep dipped on the first day were lame. It was only the flocks dipped on the second day which were affected. Heavy sheep were more prone to severe lameness than younger, lighter individuals.

There was a vast improvement in the afflicted flocks between the first and second visits; many had recovered from their lameness, although somewhere around a fifth of the originally lame sheep were still hobbling. During the second visit as many lame sheep as was feasible were caught and given 5 ml. of penicillin (300,000 IU/ml) subcutaneously. A typically lame hamel was submitted to Onderstepoort.

By the third visit, most sheep had recovered completely, but there were still some twelve sheep lame out of a flock of 250, of which 140 had been treated with penicillin. These were examined; one typical case had an enlargement of the fetlock, elbow and shoulder joints; the skin was still red but there was no heat around the joints or foot. The coronet, in particular, was very puffy; the short fleece on the cannon bone was already shedding. The other eleven sheep varied only in detail from this typical description. A flock of three year old hamels, in which all the affected sheep had been treated with penicillin and the incidence of lameness at the first visit was 75%, had much improved, and there were only 2–3% still lame. The owner reported that one sheep from this flock would not stand, and this animal was submitted to Onderstepoort for examination. A flock of 638 ewes and near-to-weaning lambs was inspected carefully. There were still a few lame animals present and the lambs had lost much condition. Whether this was because the lambs or the dams had been affected, is difficult to say. Nevertheless, it was obvious that it was the lambs which had suffered most.

No sheep died in any of the affected flocks.

The stale wash remaining in the tank six weeks after the dipping was thoroughly stirred and samples taken for bacteriological examination by both the Veterinary Research Institute, Onderstepoort, and the Cooper Technical Bureau, Berkhamsted. A sample from the mud surrounding the diptank was also submitted to the Cooper Technical Bureau.

Twenty sheep were dipped in the remaining stale wash without ill effect.

Results of laboratory examinations

These are detailed in Tables 1 and 2. *Erysipelothrix* was not isolated from any of the four sheep submitted to Onderstepoort for examination.

LIVE SHEEP SUBMITTED TO ONDERSTEPOORT FOR EXAMINATION

Origin	Sheep No.	Bacteriological Examination	Remarks
FARM A	A.1.	Pplo's from synovial fluid	—
FARM B	B.1.	*Corynebacterium ovis* from lungs	—
	B.2.	Negative	White Muscle disease
FARM C	C.1.	Negative	Photosensitisation probably due to *Hypericum* toxicity.

DIPWASH & MUD SAMPLES EXAMINED FOR *E. insidiosa*

Origin	Sample	Laboratory	Result	Remarks
FARM A	Dipwash	Cooper Technical Bureau	Positive	Low Pathogenicity
FARM B	Dipwash	Onderstepoort	Negative	—
	Dipwash	Cooper Technical Bureau	Negative	—
	*Mud	Cooper Technical Bureau	Positive	—

*Taken from surroundings of diptank.

One sheep from farm 'B' suffered from selenium deficiency, whilst the other was negative. The single sheep sent from farm 'C' showed symptoms consistent with *Hypericum* toxicity. From the single sheep forwarded from farm 'A', a pplo was isolated from synovial fluid which "in all probability was responsible for the lameness".

The Cooper Technical Bureau succeeded in isolating *E. insidiosa* from two of the three samples of dipwash sent to them (Table 2). Onderstepoort failed to isolate anything other than intestinal and faecal contaminants from the single dipwash from Farm B. Onderstepoort did not receive duplicates of the samples from which the Cooper Technical Bureau isolated *E. insidiosa.*

DISCUSSION

The histories of the outbreaks and symptoms of lameness on farms 'A' & 'B' agree closely with the classical descriptions of post-dipping lameness caused by *E. insidiosa* but the organism was not isolated from any of the sheep submitted for examination. This failure was to be expected as only well established cases were available for examination.

Harbour *et al*[11] reported great difficulty in isolating *E. insidiosa* from affected sheep until success was obtained by selecting fairly early cases showing some erythema, and culturing in 0.1 per cent glucose broth a small piece of subcutaneous tissue removed, with aseptic precautions, from the affected limb. After preliminary incubation at 37°C for 24 hours, the broth culture was plated. In successful cases this yielded a pure culture of small Gram positive organisms, proved by subsequent cultural, biochemical, serological and pathogenicity tests to be *E. insidiosa.* Early examination of affected animals was not possible in any of the cases reported here.

The disappointing results of the dipwash analyses further hinder making a positive diagnosis. Again it is essential to obtain early samples, although "the organisms grow as well in fouled dipwash as in 1 per cent glucose broth" and persist for a longer period in the former[11]. Under average conditions the infectivity of the wash then decreases on further standing. "It is likely that this is due to overgrowth of other organisms with a natural reduction in population of the pathogen"[2].

The failure of the twenty sheep, dipped 6 weeks after the main dipping on farm 'B', to develop lameness, could have been because *E. insidiosa* infection in the bath had fallen over the post-dipping period. It will be recalled that the organism was not isolated from the dipwash, only from the mud surrounding it. Furthermore, Ault and Diego[12] showed that reinoculation of experimentally infected sheep after thirteen days revealed the "existence of an apparent solid immunity".

Although Whitten *et al*[2] reported no rapid clinical response to penicillin, the total dose which they employed was on the low side, 100,000—150,000 units. In addition, cases which they treated were well established. This was true also of the cases on farm 'B' but it is possible that better results might have been achieved with earlier treatment.

Despite the failure to implicate *E. insidiosa* consistently in these outbreaks of post-dipping lameness, there is no doubt that the outbreaks were associated with dipping. Furthermore, the similarity of the symptoms observed in these outbreaks to those described in the literature constitute circumstantial evidence implicating *E. insidiosa.*

It is worthy of note that the addition of 0.04% As_2O_3 or 0.04% $CuSO_4$ to any dipwash is sufficient to prevent the occurrence of post-dipping lameness. The increased use of syn-

thetic insecticides for the dipping of sheep has led to the employment of dipwashes having no bacteriocidal or bacteriostatic properties. The risk of outbreaks of post-dipping lameness is increasing and recommendations for the routine addition of suitable bacteriocidal or bacteriostatic compounds to such dipwashes would appear advisable.

Acknowledgements

The authors acknowledge the full co-operation of the Veterinary Research Institute, Onderstepoort, and the Cooper Technical Bureau, Berkhamsted, for undertaking the bacteriological investigations reported herein.

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Jl S. Afr. vet. med. Ass. 38 (4): 425-430 (1967)

THE THERAPEUTIC CONTROL OF CALF PARATYPHOID (*S. DUBLIN* INFECTION)

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SUMMARY

Four drugs, chloramphenicol, furazolidone, Sulpha 18605-Ba (Sulphamethylphenasole-Ciba), and neomycin were tested for efficacy against *S. dublin* infection in calves. The trial involved 54 calves.

Fully susceptible animals were artificially infected intraduodenally with a known pathogenic strain of *S. dublin* and treatment was carried out for four days with each drug after the calves were severely ill. Survivors were slaughtered four weeks after infection.

An efficacy index (EI), based on the percentage of survivors and the percentage of carriers, was established. Chloramphenicol had an EI 77.7, furazolidone 50, Sulpha 18605-Ba 33.3, and neomycin 16 compared to 10 in the untreated control group.

INTRODUCTION

Various antibiotics and bacterial drugs have been employed in the treatment of salmonellosis in humans and animals. Sulphadiazine[1], phthalylsulphathiazole[2], neomycin[3], furazolidone[4] and chloramphenicol [6,7,8] have been used in calves. Of these drugs furazolidone is used most frequently but over-dosage and prolonged administration cause nervous disturbances, incoordination and hyperaesthesia [4,9].

Chloramphenicol is considered the most effective drug against salmonellosis in the human[10]. This conclusion was based entirely on antibiograms where 95 per cent of all *Salmonella* isolates were found to be sensitive to chloramphenicol, tetracycline, furazolidone and penbritin, with kanamycin and poramomycin (Humatin) proving less effective.

Drugs which appear effective *in vitro* often fail to control natural outbreaks of salmonellosis[11]. Chloramphenicol and tetracycline, for example, were both found to be effective against *Salmonella* organisms *in vitro*, but tetracycline had no effect *in vivo*[12]. In spite of this limitation, the continual use of antibiograms is of great importance in the recognition of drug resistance in pathogenic bacteria, the occurrence of which has been reported lately with increasing frequency[13–22].

Drugs may also prolong the faecal excretion of *Salmonella* organisms for a considerable period after the disappearance of clinical symptoms[11,12,23]. Dixon[11] employed a number of antibiotics including neomycin, streptomycin, ampicillin, tetracycline and chloramphenicol, as well as sulphonamides in the treatment of natural outbreaks of salmonellosis in man. Sulphonamides were completely ineffective. Irrespective of the drugs used, children continued to excrete *Salmonella* organisms in their faeces for considerable periods after clinical recovery and cessation of treatment. Comparison between treated and untreated patients supported a previous report[23] that treatment may prolong excretion of the pathogen. Dixon suggests that natural 'resident' flora in the intestinal tract assists in the clearance of pathogens, and that destruction of the flora during treatment is responsible for prolonging the period of excretion.

Van der Walt and Botes[24] found that calves, artificially infected with *S. dublin*, recovered dramatically following treatment with a new sulphonamide, *Sulpha* 18605-*Ba*. All three calves used in the intial experiment recovered without any supportive treatment but no controls were kept at the time.

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As a result of this observation a more elaborate trial was undertaken to compare the efficacy of Sulpha 18605-Ba with other drugs used for the treatment of salmonellosis in calves. A number of calves infected with *S. dublin* under identical conditions was treated with chloramphenicol, furazolidone, neomycin and Sulpha 18605-Ba and controls were included in the experimental groups.

Materials and Methods

Calves

One to two week old calves were obtained from dairies maintaining a high standard of hygiene. The serum of each calf was tested for the presence of agglutinins specific for *S. dublin* and *S. typhimurium* and only animals completely devoid of serum aggluntinins to these two *Salmonella* serotypes were used.

The experimental animals were placed singly in pens and bucket fed. Their temperatures were taken daily at 7 a.m.

Salmonella dublin strain

The virulence of the *S. dublin* strain used was determined by the mouse-mucin virulence test described by Botes[25]. The most virulent and antibiotic-sensitive strain was used throughout.

Exposure

The calves were infected artificially at the age of four weeks by the method described by Botes[25]. Each animal received 1 ml of an overnight broth culture of *S. dublin* diluted 1:50 in sterile saline, intraduodenally.

Treatment

Groups of infected calves were matched for size, weight and general condition, with one group serving as a control in each trial. The others were treated with one of the experimental drugs. Details are given in the table.

Treatment was commenced only when all the calves showed advanced clinical signs of paratyphoid including pyrexia, listlessness, anorexia and a profuse greyish-yellow diarrhoea. In most groups treatment was delayed until one calf had died and the others were too weak to stand or showed advanced symptoms. No supportive treatment was given unless it is otherwise specified.

The decision to delay treatment was based on conditions occurring on most farms where calves would be severely ill before treatment is instituted.

Treatment continued daily for a period of four days with half the daily dose being given in the morning and the other half 12 hours later.

Temperature reaction, the nature of the diarrhoea, appetite and general condition were noted throughout the period of illness and the faeces were cultured for *S. dublin* prior to, and after the cessation of treatment.

Individual trials were terminated four weeks after exposure when the survivors from all groups were slaughtered. *Post mortem* examinations were conducted on all the animals and bacteriological examinations of the liver, gall-bladder, spleen, mesenteric lymph nodes and intestinal contents of each calf were carried out.

Drugs and dosage rate

The following drugs and dosages were employed:

Chloramphenicol: 30 mg/Kg divided into two daily doses.

Furazolidone: 500 mg twice daily.

Sulpha 18605*Ba-**: 150 mg/Kg divided into two daily doses.

Neomycin sulphate: (350 mg neomycin base) 500 mg twice daily.

All the drugs were dosed orally.

Results

Controls

Of the 20 untreated controls in the experiment, four survived of which two became carriers.

Chloramphenicol

Of the nine calves dosed in this experiment three were too weak to stand at the commencement of treatment. They refused their milk completely and suffered from an uncontrollable catarrhal diarrhoea. In spite of these symptoms all but one of the treated calves improved dramatically and were on their feet and feeding 16 hours after commencement of the treatment. There was a close correlation between the gradual drop in fever and the cessation of diarrhoea. All eight calves had recovered completely one day after the treatment was stopped.

Faeces cultures were positive for *S. dublin* two days prior to and on the day of commencing

*Sulphamethylphenasole, Ciba, Basel.

treatment, but were negative after the fourth, sixth and subsequent days of sampling. With the exception of one animal, which yielded a positive culture from the gallbladder, the group was negative at *post mortem* examination four weeks after commencement of the experiment.

One of the group died within a few hours of receiving the first dose of chloramphenicol but this was not unexpected as the animal was in a poor condition. The *post mortem* examination revealed a fairly extensive muco-purulent pneumonia from which *Corynebacterium pyogenes* was isolated. *S. dublin* was recovered from the liver, spleen and intestinal tract.

The four controls all died within six days after having developed typical symptoms. *S. dublin* was isolated from them all.

Furazolidone

The ten calves treated with furazolidone were divided into two equal groups. One group received, when deemed necessary, additional supportive therapy in the form of a solution of physiological saline with five per cent dextrose administered intravenously or intraperitoneally, but the former route is preferred.

One calf in each group died of paratyphoid. Two survivors in the group which did not receive supportive therapy and one in the group which did became carriers. In general, the latter group had a slightly shorter convalescent period than those receiving furazolidone alone. The general response pattern was similar to the chloramphenicol group but diarrhoea persisted for one or two days longer.

Three calves developed a cough followed by a muco-purulent nasal discharge which persisted until the day of slaughter. At *post mortem* examination all three revealed areas of lung consolidation and localized pneumonia.

Sulpha 18605-Ba (Sulphamethylphenasole).

Three of nine calves in this group died after convalescent periods lasting up to 14 days. Although the fever persisted for only slightly longer than in the chloramphenicol group, diarrhoea only started declining on the fourth day of treatment and was still evident on the 14th day when the last calf died.

S. dublin was recovered from the three dead calves and, at irregular intervals, from the faeces of four survivors. In the latter *S. dublin* was also isolated from the intestinal tracts and gall-bladders after slaughter.

Neomycin

Three of the six calves in this group died and two of the three survivors yielded *S. dublin* isolates when slaughtered.

Although the fever subsided more rapidly than in any calf of the other experimental groups, diarrhoea persisted for the least seven days after treatment was commenced. In two calves diarrhoea was still present on the day of slaughter.

Discussion

To be regarded as an effective treatment for calf paratyphoid, a drug must fulfil certain criteria. Apart from ensuring survival, the most important requirement is the elimination of carriers of the disease, as these not only endanger the health of the herd but may also become a public health hazard.

When comparing the effect of chloramphenicol and furazolidone on the survival rate alone it will be seen that there is a difference of only eight per cent in the two groups (See table), but furazolidone yielded 27 per cent more carriers than chloramphenicol. In order to compare the efficiency of the two drugs a combination of survival and carrier rates must be used.

Table

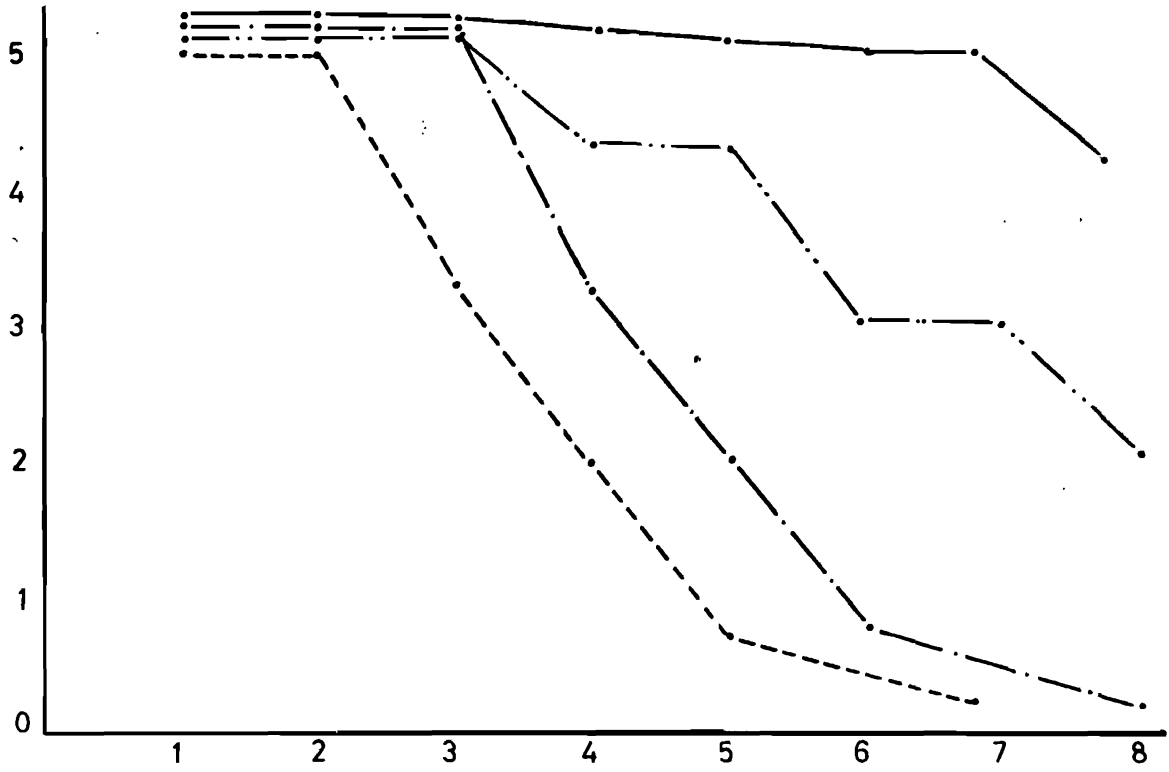
Effects of Therapy

Drug	No calves in group	Survivors	Non-Carriers	Efficacy index
Chloramphenicol	9	8	7	77.7
Furazolidone	10	8	5	50.0
Sulpha 18605-Ba	9	6	3	33.3
Neomycin	6	3	1	16.6
Controls	20	4	2	10

GRAPH 1. Duration of diarrhoea.

Diarrhoea

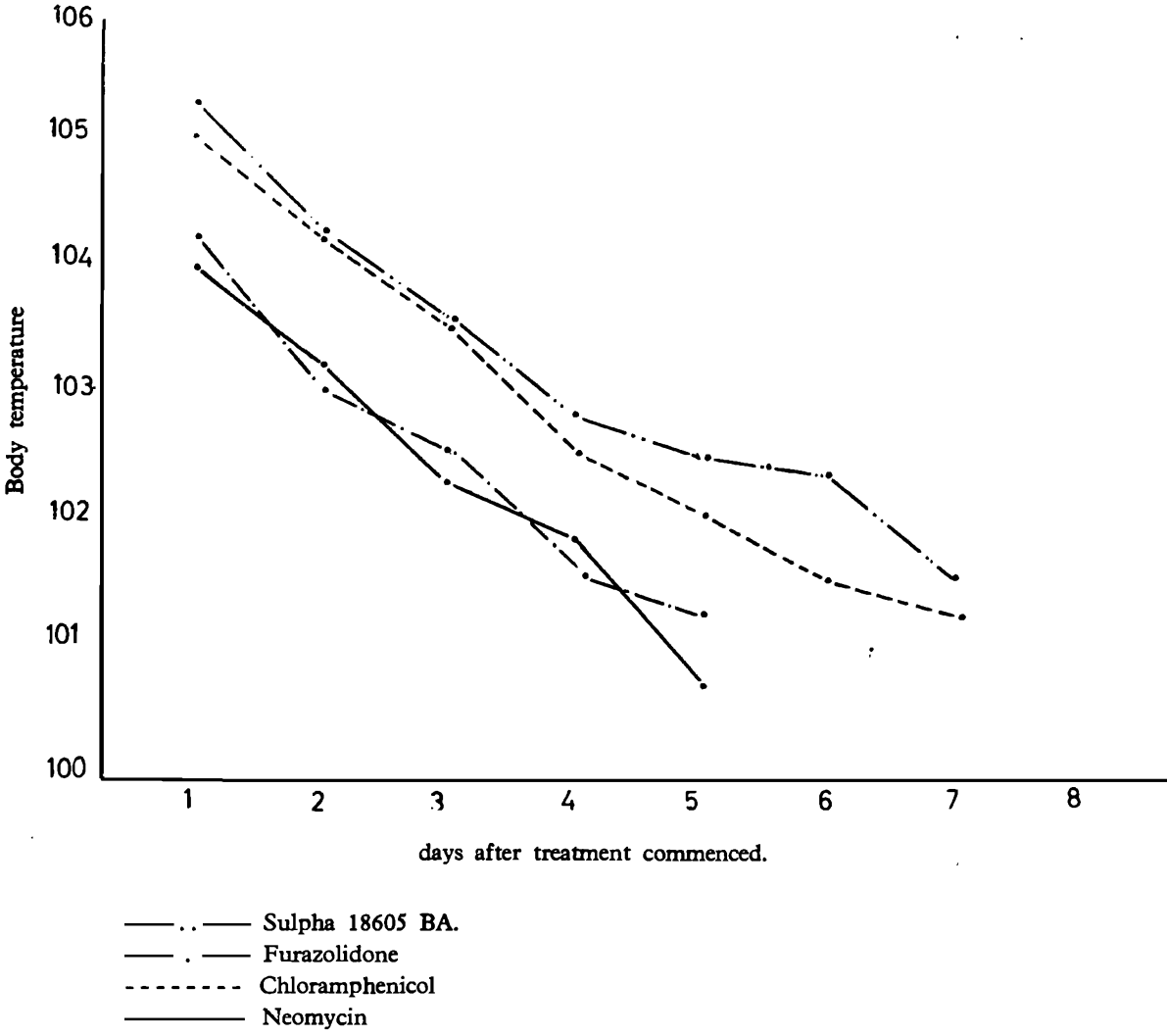
1 = normal
2 = loose
3 = very loose
4 = typical greyish-yellow
5 = muco-membranous (scrambled eggs)



days after treatment commenced.

——..—— Sulpha 18605 BA.
——.—— Furazolidone
- - - - - - - - Chloramphenicol
———— Neomycin

GRAPH 2. Temperature Response. These data represent the average figures per group per day.



For a drug to be 100 per cent effective, all treated animals should survive and there should be no carriers. The efficacy index (EI) can therefore be expressed as the percentage of the group which survived as non-carriers. Using this formula, the only reasonably effective drug in the trial seems to be chloramphenicol with furazolidone, Sulpha 18605-Ba, and neomycin following in order of decreasing efficacy.

The duration of diarrhoea is another important criterion. Prolonged diarrhoea may retard a young calf to such an extent that it remains an unprofitable runt for the rest of its life. Here again chloramphenicol suppressed diarrhoea in the shortest time, closely followed by furazolidone. Sulpha 18605-Ba had a much slower effect and neomycin, compared with the other drugs, had virtually no effect on the diarrhoea.

Although the effect of scouring can be minimized with a combination of drugs and electrolyte therapy[26], this trial was modelled on

conditions normally occurring in field outbreaks, and the suppression of diarrhoea by the individual drugs is therefore regarded as important.

A return of body temperature to normal is often regarded as an indication of drug efficacy. That there exists little basis for this assumption is proved by the temperature reaction of the different trial groups. The neomycin group responded the quickest while it took two days longer for the chloramphenicol group to become normal.

The incidence of secondary pneumonia in the furazolidone treated group was not observed in the rest of the 54 calves in the experiment. The concurrent administration of a broad spectrum antibiotic to combat secondary pneumonia is essential to eliminate this hazard.

Conclusions

Of the drugs chloramphenicol, furazolidone, Sulpha 18605-Ba, and neomycin, none were efficacious in eliminating all deaths and carrier states.

Chloramphenicol with an efficacy index of 77.7 proved far superior to the other drugs.

Furazolidone, a widely used drug for the treatment of paratyphoid in calves, had an efficacy index of 50 and failed to prevent secondary infections when used alone.

Sulpha 18605-Ba, (EI = 33.3), gave disappointing results and cannot be recommended for the treatment of salmonellosis.

Neomycin, (EI = 16) had virtually no effect on the disease.

Acknowledgements

The Chief, Veterinary Research Institute, Onderstepoort is thanked for permission to publish this article. Ciba Ltd. are thanked for supplies of Sulpha 18605-B.A.

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THE EFFECT OF SODIUM-CARBOXY-METHYL-CELLULOSE ON THE SEDIMENTATION AND VIABILITY OF BRUCELLA ORGANISMS IN SUSPENSION

F. D. HORWELL*

SUMMARY

Sodium-carboxy-methyl-cellulose (C.M.C.), in concentrations of 0.06% causes total sedimentation of *Brucella* organisms from suspensions in the range of pH 5.0 to pH 10.0 within 16 hours while held at 4°C. Sedimentation is influenced by the pH of the suspension and by the C.M.C. concentration but not by the bacterial cell density.

C.M.C. appears to be a specific sedimenting agent for *Brucella* organisms and prolongs their viability in suspension.

INTRODUCTION

Suspensions of *Brucella* organisms more concentrated than can be obtained in aerated liquid culture (± 5% bacterial cell volume) are necessary for the production of freeze-dried *Brucella* S 19 and Rev. 1 vaccines in multi-dose vials. Centrifugation severely limits the amount of suspension which can be handled and introduces a high rate of contamination.

To meet the increased demands for these vaccines it became necessary to develop a simpler and safer method of concentration which did not adversely affect the survival of the organisms.

Sedimentation of the *Brucella* organisms in occasional inoculum suspensions held at 4°C had been observed. Repated tests for purity, viability and variation had shown these samples to be no different from the unsedimented majority and the sedimentation was ascribed to an excess of redissolved agar since each sample was derived from the suspended surface growth of one culture on potato-infusion agar medium.

A series of tests on substances soluble in water and readily sterilized by heat were conducted on suspensions of *Brucella* S 19 and Rev. 1. Agar, potato infusion and potassium alum produced no trace of sedimentation; ammonium alum caused 25% sedimentation and gelatine, gum acacia and "Fondin" (methyl-cellulose) all brought about total sedimentation of the *Brucella* organisms at 4°C. Gelatine was unsuitable because of its gel-forming nature at lower temperatures and gum acacia because of subsequent problems associated with freeze-drying and re-constitution.

Comparative tests on "Fondin", „Methocel" (Dow) and various industrial grades of sodium-carboxy-methyl-cellulose (C.M.C.) established that the pure grade, high viscosity C.M.C. in a concentration of 0.06% produced the best results with total sedimentation of the organisms within 16 hours at 4°C[1,2].

Further tests have been conducted to establish the optimum conditions for the sedimentation of *Brucella* organisms by C.M.C. and its influence on the viability of *Brucella* organisms in suspension. The effect of C.M.C. on the sedimentation of other bacteria has also been investigated.

METHODS

Optimal conditions for the sedimentation of *Brucella* organisms in suspension were determined for:

(*a*) bacterial cell concentrations of 10%, 5% and 1% cell-volumes established by centrifugation in Fitch-modified Hopkins tubes at 2500 r.p.m. for 25 minutes.

(*b*) pH values of pH 3.0, pH 4.0, pH 5.0, pH 6.0, pH 7.0, pH 8.0 and pH 10.0 by suspending the *Brucella* organisms in buffered saline

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solutions to produce cell concentrations of 10%, 5% and 1% for each pH value.

(*c*) C.M.C. concentrations of 0.005%, 0.01%, 0.04%, 0.05%, 0.06%, 0.08%, 0.1% and 0.14% by the addition of a concentrated solution to the suspensions of organisms in amounts sufficient to produce the required final concentrations.

Equal volumes of all suspensions were placed in test tubes at 4°C over-night and left undisturbed for the organisms to precipitate.

The degree of sedimentation was noted as 4+ (total sedimentation), 3+ (75% sedimentation), 2+ (50% sedimentation) 1+ (25% sedimentation) and — (trace or no visible sedimentation).

To establish whether the promotion of sedimentation by C.M.C. could be applied to other bacteria similar tests were conducted with *Brucella abortus*, *Streptococcus pyogenes*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Corynebacterium ovis*, *Corynebacterium pyogenes*, *Pasteurella haemolytica* and *Salmonella dublin* in suspensions at pH 3.0, pH 7.0 and pH 10.0 to which C.M.C. was added to produce final C.M.C. concentrations of 0.04%, 0.06% and 0.08%. Control tests without C.M.C. were included for each bacterial suspension to determine the extent of unassisted sedimentation.

The effect of C.M.C. on the survival of *Brucella* organisms in suspension was investigated on two groups each representing three random batches of S 19 vaccine.

The freeze-dried contents of the vials were reconstituted to their original volume in distilled water whereupon 1 ml was immediately transferred to bottles containing 9 ml sterile diluent viz.

i. distilled water,
ii. buffered saline, pH 6.4 and
iii. 0.1% aqueous solution C.M.C.

Further ten-fold serial dilutions of each sample were made in the three diluents to a dilution of 10^{-9} and plated on four separate Albimi agar plates for counting of the viable organisms present by the modified (measured drop) method of Miles and Misra[3].

In every sample the first plating was made 5 minutes after the reconstituted sample had been transferred to the diluent. The diluted suspensions were held at room temperature (25°C—28°C) and samples were again plated after two hours and six hours. Each sample was thoroughly re-suspended before plating. The inoculated plates were left undisturbed for an hour to allow the drops to dry before being incubated in the inverted position at 37°C for five days after which the clear, well-developed colonies were counted.

A similar evaluation of three other vaccine batches was made to compare the rates of decline in viability at 15 minute intervals.

Results

The results of the sedimentation tests to determine the optimum conditions for sedimentation of *Brucella* organisms in suspension are well graduated showing no sedimentation by 0.04% C.M.C. at all pH values from pH 3.0 to pH 10.0, and by 0.05% C.M.C. at pH 3.0 and pH 4.0. With the latter concentration 50% sedimentation occurred at pH 5.0 and pH 6.0, 75% sedimentation at pH 7.0 and total sedimentation at pH 10.0. C.M.C. concentrations of 0.06% produced 75% sedimentation at pH 4.0 and total sedimentation at all higher values. Total sedimentation was obtained at all values from pH 3.0 to pH 10.0 by 0.10% C.M.C.

Bacterial cell concentration had no influence on the degree of sedimentations. (See Table 1).

The investigation into the influence of C.M.C. on the sedimentation of several other bacteria revealed that *Brucellae* were totally sedimented by C.M.C. but showed no trace of sedimentation in the control samples without C.M.C. *Streptococcus pyogenes*, *Corynebacterium ovis* and *Corynebacterium pyogenes* sedimented totally with and without C.M.C. *Staphylococcus aureus* which was totally sedimented by C.M.C. showed 50% sedimentation in the control samples. The sedimentation of *Salmonella dublin* was increased from 25% in the control suspension to 50% in the presence of C.M.C. Sedimentation of *Pasteurella haemolytica* and *Pseudomonas aeruginosa* did not occur in either C.M.C. or in the control (Table 2).

All suspensions of *Brucella* organisms in 01.% aqueous solution of C.M.C. retained higher viability after two hours at 25°C to 28°C than did those in buffered saline and distilled water. A survival rate of 25% was obtained in C.M.C. solution after six hours whereas all the organisms in buffered saline and in distilled water had become non-viable (Table 3).

TABLE 1.—SEDIMENTATION OF BRUCELLA S19 BY SODIUM-CARBOXY-METHYL-CELLULOSE

C.M.C. %	Bact. Cells %	pH 3.0	pH 4.0	pH 5.0	pH 6.0	pH 7.0	pH 8.0	pH 10
0.005	10	—				—		—
	5	—				—		—
	1	—				—		—
..0.01	10	—				—		—
	5	—				—		—
	1	—				—		—
0.04	10	—	—	—	—	—	—	—
	5	—	—	—	—	—	—	—
	1	—	—	—	—	—	—	—
0.05	10	—	—	2	2	3		4
	5	—	—	2	2	3		4
	1	—	—	2	2	3		4
0.06	10	—	3	4	4	4	4	4
	5	—	3	4	4	4	4	4
	1	—	3	4	4	4	4	4
0.08	10	2	4	4	4	4	4	4
	5	2	4	4	4	4	4	4
	1	2	4	4	4	4	4	4
0.10	10	4				4		4
	5	4				4		4
	1	4				4		4
0.14	10	4				4		4
	5	4				4		4
	1	4				4		4

4 = 100% sedimentation
3 = 75% sedimentation
2 = 50% sedimentation
1 = 25% sedimentation
— = No sedimentation
Blank spaces indicate: test not done.

TABLE 2.—THE EFFECT OF C.M.C. ON THE SEDIMENTATION OF BACTERIA IN SUSPENSION

	pH 3.0			pH. 7.0			pH 10.0			Control		
	C.M.C. 0.04%	C.M.C. 0.06%	C.M.C. 0.08%	C.M.C. 0.04%	C.M.C. 0.06%	C.M.C. 0.08%	C.M.C. 0.04%	C.M.C. 0.06%	C.M.C. 0.08%	pH 3.0	pH 7.0	pH 10.0
Brucella S 19 *abortus viable.*	2	3	4	2	3	4	4	4	4	—	—	—
Brucella S 19 *killed*.....	2	3	4	2	4	4	4	4	4	—	—	—
Streptococcus pyogenes.. ..	4	4	4	4	4	4	4	4	4	4	4	4
Staphylococcus aureus	2	2	4	3	4	4	1	3	4	2	2	2
Pseudomonas aeruginosa...	—	—	—	—	—	—	—	1	1	—	—	1
Corynebact. ovis.	4	4	4	4	4	4	4	4	4	4	4	4
Corynebact. pyogenes.	4	4	4	4	4	4	4	4	4	4	4	4
Pasteurella haemolytica. ..	—	—	—	—	—	—	—	—	—	—	—	—
Salmonella dublin.....	2	2	2	2	2	2	2	2	2	1	1	1

— No sedimentation
1 25% sedimentation
2 50% sedimentation
3 75% sedimentation
4 Total sedimentation.

Table 4, representing the average of the counts on the three vaccine batches used in Group 2, shows a very gradual decline in viability of those organisms suspended in C.M.C. but a more rapid loss when suspended in buffered saline or in distilled water.

TABLE 3.—SURVIVAL OF BRUCELLA S 19 IN THREE DILUENTS (AVERAGE COUNTS OF THREE BATCHES)

GROUP 1

Diluent.	Viable Organisms x10⁹		
	5 Minutes	2 hours	6 hours
Distilled water.....	518	0	0
Buffer-saline.....	749	180	0
C.M.C. 0.1%.....	1,324	1,108	349

That the concentration of organisms in suspension has no influence on the sedimentation is demonstrated by the identical results obtained from samples containing 1%, 5% and 10% bacterial cells.

C.M.C. in concentrations of 0.04% to 0.08% in bacterial suspensions the pH values of which are in the range pH 3.0 to pH 10.0, has a significant sedimenting influence on *Brucella* only. The normal precipitation rates of the other bacteria tested were either unaffected or only slightly accelerated.

The use of C.M.C. in suspensions of *Brucella* S 19 had a markedly beneficial effect on the survival of the organisms. As a vehicle for the dilution of suspensions and as a medium for reconstitution of lyophilized vaccine, a solution of 0.1% is preferable to distilled water or buffered saline. This knowledge is of value in the reconstitution and dilution of S 19 and Rev. 1 vaccines for dosage evaluation and in field practice where a multi-dose vial might remain reconstituted for 30 minutes or longer before the last dose is administered. The use of C.M.C. in the preparation of brucella vaccines has the added advantages of being easily sterilized by heat, non-foaming, bacteriologically non-growth supporting, bland and non-irritant to animal tissue.

TABLE 4—SURVIVAL OF BRUCELLA S 19 IN THREE DILUENTS (AVERAGE COUNTS OF THREE BATCHES) GROUP 2

Diluent	Viable Organisms x10⁹								
	5 min	¼ hr	½ hr	¾ hr	1 hr	1½ hrs	1¾ hrs	2 hrs	2½ hrs
Distilled water.....	1250	933	1005	826	1193	587	400	333	292
Buffersaline.....	2500	2500	2000	1600	1500	900	560	300	
C.M.C.....	2650	2650	2535	2317	2067	2100	2000	1977	1617

DISCUSSION

The sedimentation tests establish that in the pH range of brucella liquid culture (pH 6.8—pH 7.4) total sedimentation of the organisms is caused by the addition of 0.06% C.M.C. to the suspensions while 0.05% C.M.C. is the minimum for partial sedimentation. At this concentration the pH value of the suspension is critical: no sedimentation occurs at pH 3.0 and pH 4.0, 50% at pH 5.0 and pH 6.0, 75% at pH 7.0 and total sedimentation at pH 10.

ACKNOWLEDGEMENTS

The Chief, Veterinary Research Institute, Onderstepoort, is thanked for his permission to publish this article and Miss H. E. Smith is thanked for her assistance in making the bacterial counts.

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Jl S. Afr. vet. med. Ass. 38 (4): 435-437 (1967)

AN OUTBREAK OF BOVINE BESNOITIOSIS IN THE ORANGE FREE STATE, REPUBLIC OF SOUTH AFRICA

R. D. BIGALKE & J. H. SCHOEMAN*

SUMMARY

An outbreak of bovine besnoitiosis in Afrikaner cattle on a farm in the Orange Free State Province is reported. This is the first record of the disease in the highveld well outside the bushveld, bankenveld and lowveld regions of Transvaal, where it is highly enzootic.

Thirty-six head of cattle, constituting 10.8 per cent of the herd of 333, were infected as detected by the presence of cysts in the scleral conjunctiva. Only five (1.5 per cent of the herd) showed clinical sclerodermatitis. No skin lesions were visible in the rest which had a subclinical form of the disease. The epidemiological significance and implications of the outbreak are discussed.

INTRODUCTION

In the Republic of South Africa bovine besnoitiosis has hitherto been regarded as a disease that is confined to the bushveld, bankenveld and lowveld of Transvaal where cattle ranching is extensively practised[1,2]. The climate is largely subtropical in these areas that are a veritable paradise for arthropods and the diseases transmitted by them, despite having a rather low rainfall generally.

The object of this report is to call attention to an outbreak of the disease which occurred on a farming unit in the Bothaville district of the Orange Free State, i.e. in the highveld proper which has a much colder climate.

HISTORY

The first (unconfirmed) case of besnoitiosis occurred in January, 1966, in a two-year-old ox with severe sclerodermatitis and alopecia. The lesions were ascribed to lumpy skin disease and the animal died from exhaustion after a few weeks. About a month later a nine-year-old bull developed a severe illness accompanied by fever and swelling of the prepuce, i.e. symptoms of the acute anasarcatous stage of besnoitiosis; sclerodermatitis developed subsequently, but it was again erroneously regarded as being due to lumpy skin disease. The bull was, however, subsequently seen by Mr. B. van Wyk of Potgietersrust, who is well acquainted with bovine besnoitiosis. By virtue of the classical symptomatology and the presence of cysts in the scleral conjunctiva (sc), he expressed the belief that it was a typical case of bovine besnoitiosis. The bull became sterile and was slaughtered nine months later.

A third case occurred in March, 1967. A five-year-old cow showed general signs of severe illness accompanied initially by fever and a stiff gait. Sclerodermatitis developed subsequently. On advice from Onderstepoort the owner submitted a skin specimen, and the diagnosis was confirmed histologically. He then recognized three cows and a three-year-old bull, all showing rather mild scleroderma, as also being infected. The three cows had not been seen in the early stages, but the bull had suffered from an "unidentified" disease manifested by a severe thermal reaction, a stiff gait, lassitude and general symptoms of an acute illness in April, 1967.

MATERIALS AND METHODS

Situation. The unit consists of two farms each about 1000 morgen in size lying fairly close to each other on the Vals and Vaal rivers. The owner breeds stud Afrikaner cattle. Except for the introduction of two bulls from other highveld farms, the herd has been closed since

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1953. A few Jersey cows and cross-bred cattle owned by Bantu are also present. The animals drink at the rivers, dams and bore-holes. No antelope are present on the farms.

Examination. On the 24th July, 1967, all the cattle on the farms were examined for scleroderma and for cysts of *Besnoitia besnoiti* (Marotel, 1912) in the sc of both eyes; the number of cysts was estimated as described previously[3].

Results

Thirty-six (10.8 per cent) of the 333 head of cattle examined had cysts in the sc. Five (1.5 per cent of the herd and 13.9 per cent of the detected cases) showed clinical sclerodermatitis of varying degrees of severity, and these all had more than 50 cysts in the sc of both eyes. No skin lesions could be seen in the remaining 31 cattle, in which the number of cysts varied from over 50 in both eyes to only one in the sc of a single eye.

All the infected animals were Afrikaners. Two of them were bulls, of which one was clinically infected, whereas the other had only a few cysts in the sc. The rest were females of varying ages. The age-distribution of the cases is illustrated in Fig. 1. There were no detectable cases among the unweaned calves. An eight-month- and a two-year-old heifer were the youngest infected animals. Twenty-eight (77.8 per cent) of the animals were older than 6 years, with the highest incidence (12 or 33.3 per cent) in the over 6 to 7.5 years group. The over 12 to 13.5 years group with 8 cases (22.2 per cent) was a close second. With the exception of the young bull that had been introduced two years before he acquired the disease, all the infected animals had been born and bred on the farm.

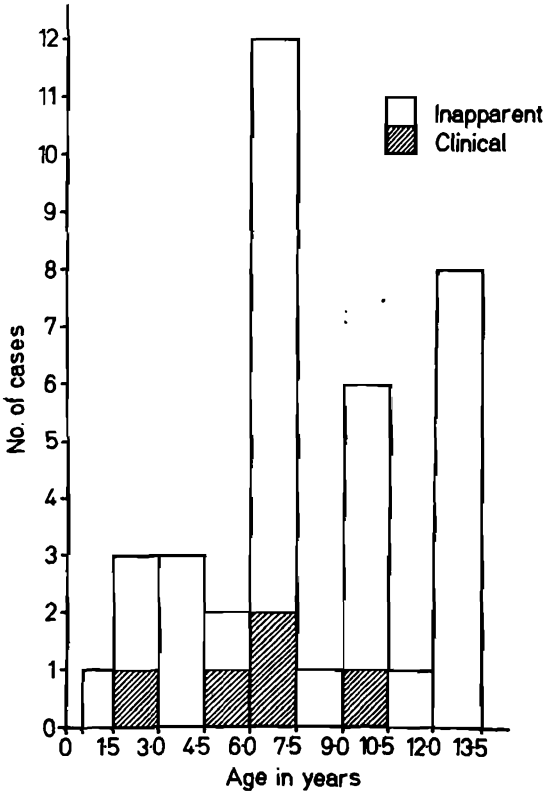

Fig. 1. Histogram illustrating the age-distribution of clinical and inapparent forms of bovine besnoitiosis.

Discussion

The high infection rate encountered on this highveld farm is comparable with that observed in the enzootic regions on some farms where the clinical disease has been known to occur for many years[2,4]. Although the rate of spread is not necessarily identical everywhere, it can be assumed that bovine besnoitiosis has probably been present much longer than suggested by the 18 months period since it was first recognised.

There is good experimental evidence that chronically infected cattle serve as a source of infection for susceptible ones[5,2], and one can assume that somehow they must also have been responsible for the introduction of the disease in this instance. Mechanical transmission of bovine besnoitiosis by blood-sucking insects is also well-substantiated[6,5,2] and was probably also involved in the process. Thus it may have been introduced from infected cattle passing along the roads, from neighbouring farms, at a show, or from cattle introduced several years ago but no longer present. Mosquitoes, *Stomoxys calcitrans* and *Culicoides* spp. are very plentiful at times, and one or more of them were probably responsible for further dissemination once the infection had been introduced. This would also explain the seasonal incidence of clinical cases.

The marked preponderance of the disease in cattle, especially cows, that were over six years of age is very interesting and may be significant, but the figures should be interpreted with some reserve. There were only four clinical cases that were actually seen in the early stages of the disease and of which the approximate time of infection is therefore known. With one exception, they were under six years of age. The others were detected by the presence of cysts in the sc which denotes a chronic infection. This means that they may have acquired the disease much earlier in their lives, and that its apparent preference for older animals may be due to an accumulation of these chronic cases.

This outbreak shows that bovine besnoitiosis can occur and maintain itself among cattle in the complete absence of impala and blue wildebeest. Hence it furnishes good circumstantial evidence in favour of the concept expounded previously that these antelope are not involved in the epidemiology of the disease on bushveld and lowveld farms, even though they are often present, because the strains of *B. besnoiti* that they harbour are so different from bovine strains biologically[7,2]. Regarding the transmission, the outbreak suggests that the vector is either common to both highveld and bushveld regions, or that more than one species of vector is involved; this one would expect to be the case with mechanical transmission[5,2]. The reason for the predominance of bovine besnoitiosis in subtropical regions of South Africa should therefore not be sought in some mysterious biological vector or reservoir confined to these regions, but in some other epidemiological factor(s).

It seems most unlikely that the disease is limited to only one herd in the highveld. There are probably other farms that are also infected. Its occurrence under ecological conditions as divergent as those of the bushveld and highveld suggests that there must be very few cattle-farming regions in this country where besnoitiosis will not be able to establish itself.

Acknowledgements

The writers wish to thank the Chief, Veterinary Research Institute, Onderstepoort, for permission to publish this paper. They are indebted to the State Veterinarian, Hoopstad, for assistance during the examination.

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THE HAEMATOZOA OF SOUTH AFRICAN BIRDS
II Blood Parasites of some Rhodesian Birds†

J. H. OOSTHUIZEN AND M. B. MARKUS*

SUMMARY

This report is based on blood smears from 73 individuals of 47 species of wild Rhodesian birds, examined for malaria parasites and other haematozoa. Blood films of 45 of the 73 individuals were positive for protozoa or/and microfilariae; 31 (22 species) for *Haemoproteus*, 12 (9 species) for *Leucocytozoon*, 1 (1 species) for *Plasmodium*, 11 (7 species) for *Trypanosoma* and 15 (13 species) for microfilariae. Apparent new host-parasite associations are: *Haemoproteus*, 12 species of birds; *Leucocytozoon*, 6 species; *Plasmodium*, 1 species; *Trypanosoma*, 7 species; and microfilariae, 12 species.

INTRODUCTION

The blood of the present series of Rhodesian birds was sampled during the course of a more extensive survey of the haematozoa of southern African birds, recently initiated.

The three Crowned Guineafowl, the Fork-tailed Drongo infected with *Haemoproteus* and microfilaria, the Puffback Shrike and the two Lesser Blue-eared Glossy Starlings were collected at Shamva during December 1966 whilst the single Boubou Shrike was taken near Essexvale on 18 May 1967. All the other birds were shot in Rhodesia within 35 miles of Beit Bridge between 21 and 23 December 1966.

METHODS

Smears were made from wounds or from the thoracic cavity; in some cases peripheral blood of injured birds was obtained from a leg following venous puncture, medially, by a suture needle. After staining, blood films were thoroughly searched for haematozoa.

RESULTS

Details concerning the birds which were examined are tabulated below.

BLOOD PARASITES OF RHODESIAN BIRDS:

Family and Species	No. of birds	No. +	H	L	P	T	M
PHASIANIDAE							
Crowned Guineafowl *Numida meleagris*	3	3	3	2			2
CHARADRIIDAE							
Crowned Plover *Vanellus coronatus*	1	1					1*
COLUMBIDAE							
Cape Turtle Dove *Streptopelia capicola*	4	2	1			1*	
Laughing Dove *Streptopelia senegalensis*	2	2				1*	1*
Emerald-spotted Wood Dove *Turtur chalcospilos*	1	1	1*			1*	
MUSOPHAGIDAE							
Grey Loerie *Corythaixoides concolor*	1	0					
CUCULIDAE							
Jacobin Cuckoo *Clamator jacobinus*	1	1	1?	1*	1*		
MEROPIDAE							
Little Bee-eater *Merops pusillus*	1	0					
CORACIIDAE							
European Roller *Coracias garrulus*	1	1	1	1			

*Department of Zoology, University of Pretoria.
†Presented at the First Rhodesian Science Congress, May 1967

Family and Species	No. of birds	No. +	H	L	P	T	M
BUCEROTIDAE							
Red-billed Hornbill *Tockus erythrorhynchus*	4	3				3*	1*
Yellow-billed Hornbill *Tockus flavirostris*	1	1					1*
CAPITONIDAE							
Pied Barbet *Lybius leucomelas*	1	0					
ALAUDIDAE							
Sabota Lark *Mirafra sabota*	2	0					
HIRUNDINIDAE							
Lesser Striped Swallow *Hirundo abyssinica*	2	0					
DICRURIDAE							
Fork-tailed Drongo *Dicrurus adsimilis*	2	1	1*				1*
PYCNONOTIDAE							
Black-eyed Bulbul *Pycnonotus barbatus*	1	1					1*
TURDIDAE							
Familiar Chat *Cercomela familiaris*	1	0					
SYLVIIDAE							
Icterine Warbler *Hippolais icterina*	1	1	1				
Yellow-bellied Eremomela *Eremomela icteropygialis*	2	0					
Brown-throated Eremomela *Eremomela usticollis*	1	1					1*
Barred Warbler *Camaroptera fasciolata*	1	0					
Crombec *Sylvietta rufescens*	2	2	2*	1*			
MUSCICAPIDAE							
Spotted Flycatcher *Muscicapa striata*	1	1	1				
White-flanked Batis *Batis molitor*	1	0					
LANIIDAE							
Red-backed Shrike *Lanius collurio*	2	2	2				
Boubou Shrike *Laniarius ferrugineus*	1	1		1*			
Crimson-breasted Shrike *Laniarius atrococcineus*	1	0					
Puffback Shrike *Dryoscopus cubla*	1	1		1*			1*
Three-streaked Tchagra *Tchagra australis*	2	0					
White Helmet-Shrike *Prionops plumata*	1	1		1			
White-crowned Shrike *Eurocephalus anguitimens*	1	1	1*				
Brubru Shrike *Nilaus afer*	2	0					
STURNIDAE							
Plum-coloured Starling *Cinnyricinclus leucogaster*	1	1	1*				
Blue-eared Glossy Starling *Lamprotornis chalybaeus*	2	2	2*				2*
Lesser Blue-eared Glossy Starling *Lamprotornis chloropterus*	2	2	2*			1*	
NECTARINIIDAE							
White-breasted Sunbird *Nectarinia talatala*	1	0					
PLOCEIDAE							
Buffalo Weaver *Bubalornis albirostris*	1	1	1*				
Grey-headed Sparrow *Passer diffusus*	1	1	1*				
Yellow-throated Sparrow *Petronia superciliaris*	1	0					
Red-headed Weaver *Anaplectes melanotis*	4	4	4*	3*		3*	1*
Masked Weaver *Ploceus velatus*	2	2	1				1*
Cut-throat Finch *Amadina fasciata*	1	1	1				
Melba Finch *Pytilia melba*	2	1	1	1*		1*	
Blue Waxbill *Uraeginthus angolensis*	2	1	1*				
FRINGILLIDAE							
Yellow-eye Canary *Serinus mozambicus*	2	0					
Lemon-breasted Canary *Serinus citrinipectus*	1	0					
Golden-breasted Bunting *Emberiza flaviventris*	1	1	1*				1*
TOTALS: 47 species	73	45	31?	12	1	11	15

Abbreviations: H, *Haemoproteus*; L, *Leucocytozoon*; P, *Plasmodium*; T, *Trypanosoma*; M, Microfilaria; *apparent new host-parasite records.

DISCUSSION

Haemoproteus and *Leucocytozoon* have been recorded from the Crowned Guineafowl by various authors, most recently by Oosthuizen and Markus[1] and Huchzermeyer[2]. Microfilariae have previously been reported from the same species of bird by Kerandel[3], Scott[4] and Hamerton[5]. Jansen[6], Enigk[7], Sjöbring[8], Cardmantis[9] and Hamerton[5] have respectively noted the presence of *Haemoproteus* in blood of the Cape Turtle Dove, Jacobin Cuckoo, Icterine Warbler, Spotted Flycatcher and Melba Finch. Enigk[7]

found *Haemoproteus* in the Masked Weaver and Plimmer[10] and Hamerton[5] list the Cut-throat Finch as a host of the parasite. References to *Haemoproteus* from the Red-backed Shrike are made by Ziemann[11], Wasielewski[12], Wülker[13], Böing[14] and Enigk[7] and in the European Roller by Danilewsky[15], Cardmantis[9] and Wülker[13]. The latter author refers also to *Leucocytozoon* in the European Roller. A. and M. Leger[16] observed *Leucocytozoon* in the blood of the White Helmet-Shrike.

On the basis of the material available for study, it was not possible to determine with certainty whether the Jacobin Cuckoo was in fact parasitized by *Haemoproteus* (see Table) in addition to *Leucocytozoon* and *Plasmodium*.

Acknowledgements

The authors' work on the haematozoa of southern African birds is supported by Research Grants awarded by the Frank M. Chapman Memorial Fund of the American Museum of Natural History, New York (to M. B. M.) and the South African Council for Scientific and Industrial Research (to J. H. O.). Collection of the smears from Shamva by A. N. Markus is acknowledged with thanks.

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*not seen

Jl S. Afr. vet. med. Ass. 38 (4): 441-443 (1967)

TRICHINELLA SPIRALIS (OWEN, 1835) RAILLIET, 1895 INFESTATION OF WILD CARNIVORES AND RODENTS IN SOUTH AFRICA

E. YOUNG* AND S. P. KRUGER**

SUMMARY

In a preliminary survey, undertaken in the southern part of the Kruger National Park, larvae of *Trichinella spiralis* (Owen, 1835) Railliet, 1895 have been found in muscle specimens from a lion, *Panthera* (*Leo*) *leo krugeri* Roberts, six spotted hyena, *Crocuta crocuta* (Erxleben), one black-backed jackal, *Canis mesomelas mesomelas* (Schreber) and one multimammate mouse *Praomys* (*Mastomys*) *natalensis* (A. Smith). These are the first reported cases of *Trichinella spiralis* from South Africa.

INTRODUCTION

As far back as 1948, Thienpont[1] had diagnosed *Trichinella spiralis* infestation in a spotted hyena at Marunga in the province of Katanga of the then Belgian Congo. This finding was not published; consequently previous to 1961 it was generally believed that Africa, south of the Sahara, was free of *Trichinella spiralis*[2,3]. During 1961, a few cases of the parasite in man were reported from Kenya[2]. Infestation in these cases apparently had taken place by ingestion of meat from a wild pig, *Potamochoerus porcus*. In subsequent surveys[4,5] the spotted hyena, leopard, serval cat, lion, domestic dog, brown hyena and the black-backed jackal were also found infested. In 1966 the parasite was also reported in spotted hyena from Serengeti, Tanzania[6]. Besides a suspicious clinical case in a medical student in Cape Town[7], no natural cases of trichinosis have so far been reported from the Republic of South Africa and South West Africa. During the 1940's Mönnig[8] had conducted a survey on porcine diaphragm samples from the Johannesburg abattoir with negative results. In 1908, Rickmann had examined a few pigs in South West Africa, also with negative results[9].

In a study in the Kruger National Park on infectious diseases and parasites common to wild carnivores, meat producing herbivores and man, the possibility of trichinosis in wild animals was also considered. Positive trichinoscopic examination of muscle tissues (fig.) from a lion, which was extremely emaciated and moved with great difficulty, initiated a subsequent survey to confirm the identity and determine the distribution of the parasite.

Fig. Microphotograph of an encysted larva of *Trichinella spiralis* in a muscle specimen from the diaphragm of a lion.

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Material and Methods

The distribution of the parasite in the major muscle group of positive cases, initially examined, although general and wide-spread, indicated that examination of samples from tongue, neck and diaphragmatic musculature, especially the former two, would be adequate. On this basis the survey was conducted to include finally 209 individuals representing 14 wild animal species from the southern part of the Kruger National Park only (see table for details).

Trichinoscopic examination, generally employed for the diagnosis of trichinosis in abattoirs, was used as a rapid diagnostic method in routine examinations. Owing to the relative unreliability of this method[10] in detecting slight infestations, the digestion technique[11] was also used. This method is considered to be more practicable in the examination of large samples. It was also utilized for the isolation of viable larvae for infestation of laboratory animals and recovery of adult parasites, whereby the final identification of the parasite was facilitated. Larvae were administered orally to young laboratory bred multimammate mice as white rats and guinea pigs had been found to yield a low infestation rate. Six days after infestation, the infested mice were slaughtered. The entire alimentary tract was then digested and the adult parasites were recovered.

Results

The results of the survey are given in the table.

The adult parasites, obtained from artificially infested multimammate mice, were represented by 4 males and 11 females. They were identified as *Trichinella spiralis* (Owen, 1835) Railliet, 1895 on the basis of their typical morphology[12]. Vast numbers of larvae were present in the uteri of the females, which had probably already liberated infective larvae.

Discussion and conclusions

As specimens had been collected from the southern part of the Kruger National Park only, further surveys are required in order to assess the distribution of trichinosis in the reserve as a whole, as well as in the rest of the country.

In a brief preliminary survey[13] on parasitism in and diseases of wild animals recently undertaken in the Etosha National Park, S.W.A., no cases of trichinosis were found in four jackal (*Canis mesomelas mesomelas*) and two warthogs (*Phacochoerus aethiopicus*).

Both the variety of species and the number of animals examined are too small to allow any hard and fast conclusions to be drawn at this stage. It is significant that both in the Kruger National Park and in East Africa[4,5,6] it was mainly wild carnivores that were found to be infested, and among them again chiefly the spotted hyena. Considering the latter's scavenging and cannibalistic habits, this is scarcely surprising. In view of the rôle played by rodents in the epizootiology and epidemiology of trichino-

Table: Occurrence of Trichinosis in wild animals of the Kruger National Park

Species examined	Total Number	Infested cases
1. Lion, *Panthera (Leo) leo krugeri* Roberts	5	1
2. Spotted hyena, *Crocuta crocuta* Erxleben	7	6
3. Black-backed jackal, *Canis mesomelas mesomelas* Schreber	2	1
4. Chacma baboon, *Papio (Chaeropithecus) ursinus orientalis* Goldblatt	1	0
5. Warthog, *Phacochoerus aethiopicus* Pallas	2	0
6. Buffalo, *Syncerus caffer caffer* Sparrman	36	0
7. Blue wildebeest, *Connochaetes (Gorgon) taurinus taurinus* Burchell	20	0
8. Impala, *Aepyceros melampus melampus* Lichtenstein	31	0
9. Burchell's zebra, *Equus (Hippotigris) burchelli antiquorum* H. Smith	21	0
10. Multimammate mouse, *Praomys (Mastomys) natalensis* (A. Smith)	44	1
11. Bushveld gerbil *Tatera leucogaster* (Peters)	30	0
12. Pouched mouse *Saccostomus campestris campestris* Peters	1	0
13. African bush rat *Aethomys chrysophilus* de Winton	8	0
14. Cape vulture, *Gyps coprotheres*	1	0
TOTAL	209	9

sis in the world, it is also significant that the disease could be determined in a wild rodent, albeit in one multimammate mouse only.

The negative results so far obtained by the trichinoscopic examination of the relatively large number of meat producing game animals are assuring, but should not lead to overconfidence.

The similarity in species affected in East and in South Africa, suggests that one may be dealing with the same strain of the parasite. Experimental comparison between the European and Kenyan strains proved that the latter strain was of low infectivity to domestic pigs[14].

The effects of this parasite on the wild hosts mentioned in this paper have not yet been determined. In the case of the lion, other possible causes of its poor condition were excluded: trichinosis could have been responsible for the symptoms described. The other cases appeared clinically healthy.

In relative overpopulations of wild carnivores and rodents there is usually an increased tendency to cannibalism. The opportunity for the natural transmission and propagation of *Trichinella spiralis* under such circumstances is extremely favourable. Depending on the lethal effect of trichinosis on wild animals, it may play an important rôle in the natural control of population numbers of wild carnivores and rodents.

Acknowledgements

1. Dr. L. W. van den Heever for his advice and providing us with a trichinoscope.
2. Messrs. L. J. Swanepoel, J. A. Muller, T. Robey and L. Macaulay for technical assistance.
3. Mr. N. Fairall and Dr. G. R. Thomson for their help, especially with the collection of specimens.
4. The National Parks Board for the provision of specimens and their interest in this project.
5. Dr. U. de V. Pienaar for critically revising the script.
6. The Chiefs of Veterinary Services and the Research Institute of Onderstepoort for the facilities provided and permission to publish this report.

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Jl S. Afr. vet. med. Ass. 38 (4): 444-446 (1967)

SCHISTOSOMIASIS IN SMALL STOCK IN THE POTGIETERSRUS VETERINARY AREA

L. R. HURTER AND L. N. D. POTGIETER*

SUMMARY

A severe outbreak of schistosomiasis in small stock on a farm bordering on the Limpopo river was investigated. Symptoms were typical of a severe intestinal parasite infestation.

Thirty-nine head of small stock were made available to the diagnostic centre at Potgietersrus. Various drugs were tested for efficacy.

Snails were sent for identification and faeces samples submitted to Onderstepoort for the miracidial hatching test.

Rectal biopsies proved an easy and effective method of diagnosing infestations.

INTRODUCTION

Mortality in sheep and later in goats was reported by a farmer on the Limpopo river in the Waterberg district. A sheep, *in extremis*, was brought for *post mortem* examination. It showed a massive infestation with *Schistosoma mattheei*, more than 900 pairs of parasites being counted in the mesenteric veins.

MATERIAL AND METHODS

The farmer made twenty goats and nineteen sheep available for observation and experimental purposes. The animals were brought to Potgietersrus, weighed, and divided into nine experimental groups comprising twenty-seven animals. Twelve animals being either emaciated or too young, were left as controls and as a "reservoir" of infestation. All groups were kept in stalls and not re-exposed to infestation.

Rectal biopsies of all thirty-nine animals were obtained by introducing a bowel forceps into the rectum, withdrawing the mucous membrane and snipping of a small piece. Microscopical examination of this snip, compressed between two slides, showed large numbers of spindle-shaped ova. All animals proved to be infested.

Affected bovines

One milk cow showed marked malaise. A rectal biopsy was positive for *S. mattheei*.

Ova and parasites were submitted for identification and Eloff of Pretoria University, van Eeden of Potchefstroom and Kruger of Onderstepoort all identified them as *S. mattheei*.

Faeces examination was found suitable for diagnosing infestation but we were unable to hatch ova, probably due to an excessive amount of faeces mixed with the volume of water used.

ECOLOGICAL CONDITIONS

When the farm was visited it became evident that all factors necessary for a massive build-up of intestinal parasites were present, i.e. poor grazing, limited water supplies and overcrowding.

All small stock (about eighty-four head) and eleven milk cows were grazed in the bed of the Limpopo river which had stagnant pools. This water was pumped into a concrete reservoir at the homestead and piped into troughs. All stock either drank in the pools or at the troughs. The small stock were kraaled at night.

SNAIL IDENTIFICATION

Snails were collected in the river, reservoir, troughs and irrigation furrow in the orchard. They were identified as follows:—

Bulinus (physopsis) globosus
Eupera ferruginea
Lymnaea columella

The first snail listed is known to be an intermediate host of schistosones but this was not confirmed in this instance.

*Veterinary Diagnostic Centre, Potgietersrus, Transvaal.

Molluscicidal Effects

Copper sulphate as a molluscicide in a concentration of one part per 1,000,000 (ppm) used in the reservoir had no effect on the snails. This was possibly due to the large amount of organic material in the reservoir.

Rodents (*Mastomys natalensis*) were immersed in special cages in the infested pools, reservoir and troughs for thirty minutes, prior to the application of Bayluscide*. Two months later these rodents were slaughtered and *S. mattheei* recovered from the mesenteric vessels. Bayluscide was applied at a concentration of one ppm, according to manufacturer's instructions. Unfortunately the rodent infestation test could not be applied subsequently, but according to the subsequent history and visual impressions, the treatment had had the desired effect.

Symptoms

It is interesting to note that sheep showed symptoms of an acute intestinal parasitic infestation before goats were visibly affected. Anaemia, emaciation, a watery diarrhoea, inappetence, recumbency and death were seen.

Treatment

Acting on advice of the firms supplying the anthelmintics, experimental groups were treated at various dosage rates and destroyed at different periods to determine the efficacy of the treatment as judged by the percentage worms that shifted from the mesenteric veins to the hepatic circulation. Worms in the mesenteric veins move to the portal veins ("worm shift") when treatment is effective. By comparing the number of parasites in each of the two areas, the percentage efficacy can be calculated. The parasites in the hepatic circulation are usually seen as a mass of dead worms.

Treatment was applied as follows:—

Group 1: Becanthane (Winthrop)

Becanthane was used to treat two sheep and two goats. The drug proved non-toxic but unfortunately the results were poor as efficacy varied from 1.6 to 1.7%.

Group 2: Loxon (Cooper and Nephews)

Two sheep and one goat were dosed at the rate of 300 mg/kg. After two weeks one of the sheep was destroyed and 350 parasites were present in the mesenteric circulation and 160 in the hepatic circulation, a "shift" of 30.8%. Three weeks after dosing the goat showed a 100% "shift", all 340 parasites being recovered from the hepatic circulation. The other sheep was not destroyed. Subsequently 45 goats on the farm were dosed twice at a dosage rate of 300 mg/kg without any side effects.

Group 3: 27H63 (Cooper and Nephews)

This was dosed to two goats and one sheep. The sheep showed transitory salivation the next day. The schistosomicidal action was poor, being 5.1% after two weeks and 0% after three weeks.

Group 4: Ambilhar (Ciba)

This drug is widely used in human cases of schistosomiasis. It was used as follows:—

a) 100 mg/kg was dosed to two sheep and one goat for three consecutive days. Severe clinical symptoms of salivation were observed. Autopsy on a sheep after one week showed a "shift" of 100%, 321 parasites being found in the hepatic circulation. Two weeks after dosing, a "shift" of 100% was seen in the other sheep with 430 parasites in the hepatic circulation.

b) 150 mg/kg dosed to two goats and one sheep resulted in the sheep dying within 24 hours. Symptoms as under 5(*a*) were seen. After one week a worm "shift" of 40% and after two weeks of 3% was seen at *post mortem* examination of the goats.

c) 100 mg/kg dosed to two sheep and a goat, caused toxic symptoms and *post mortem* examinations after one week showed a "shift" of 1% and 6% and after three weeks a "shift" of 98%.

As can be seen from (*b*) and (*c*) the results with single dose treatment were erratic. The same results are experienced in humans where repeated treatments are necessary to obtain cures.

* Bayer 73 — Farbenfabriken Bayer.

Post Mortem Examination

Severe emaciation and cachexia were common. A dark grey discolouration of the liver with cirrhosis and uneven surface as well as grey discolouration of the lungs with pneumonia in various stages, were typical in more than 40 necropsies.

The presence of *S. mattheei* was demonstrated in the mesenteric vessels and in severe cases also in ruminal and cystic blood vessels. A count of as many as 1,000 pairs of parasites was noted in some cases.

Histopathology

Haematin was found in the Kupffer cells in the sinusoids and macrophages in the portal veins of the liver and in some cases an extensive fatty degeneration was noted, particularly affecting the periphery of the lobules.

In the lungs haematin pigmentation and various stages of pneumonia were present. Ova were seen in the liver, lungs and visceral lymph nodes.

Conclusion

All factors necessary for a massive build-up of bilharzia were found on the farm. The underlying reason for the infestation being limited to the particular form is unknown. Faeces samples from the surrounding farms were sent to Onderstepoort for miracidial hatching, without success.

The early diagnosis of schistosomiasis, to enable effective treatment to be applied before mortality becomes general, is important. Treatment with various preparations is effective.

Acknowledgements

We wish to thank the Chief, Veterinary Field Services for permission to publish this article; Prof. Eloff, Prof. van Eeden and Mr. S. P. Kruger for the identification of parasites, ova and snails and Mr. S. P. Kruger for miracidial hatching and personal communications.

Acknowledgment is also due to the firms Cooper and Nephews, S.K.F. and Winthrop for supplying various drugs

Jl S. Afr. vet. med. Ass. 38 (4): 447-453 (1967)

TICK INFESTATION OF LIVESTOCK IN NATAL

I. The Predilection Sites and Seasonal Variations of Cattle Ticks

MAUREEN K. BAKER & F. B. W. DUCASSE*

SUMMARY

A resumé is given of the predilection sites of the common cattle ticks in Natal. Present day control practices could be altered to combat a specific tick by basing such modifications on the predilection sites, and on the known feeding and activity periods of its adult and immature stages.

INTRODUCTION

Chemical methods of control and eradication of ticks have been studied extensively in the Republic of South Africa. On the other hand, very little work has been undertaken on basic bionomics of tick life[1,2]; inter alia, seasonal variation, survival in the field, predilection sites, field infestation, rôle played by wild life and the influence of climatic factors on activity. During 1965—1966 an intensive tick survey was undertaken in Natal over a period of 12—15 months in an attempt to supplement our rather meagre knowledge on tick ecology in order to implement better tick control measures.

In this paper only the preferred attachment sites will be analysed in detail and tentative control measures based on predilection sites will be suggested.

PROCEDURE

A. FIELD COLLECTION

Weekly tick collections were made from two calves randomly selected on a representative farm at each of four altitude levels in Natal, namely,

(i) coastal zone of 0—1000 feet;
(ii) thornveld zone between 1000—3000 feet;
(iii) mistbelt zone between 3000—5000 feet;
(iv) highveld zone over 5000 feet.

The farms selected at each altitudinal level represented one with good grass and tree or shrub cover and one with sparse natural cover and little wild life, in order to gauge the effects of overgrazing the veld on tick life.

To determine the exact predilection sites of cattle ticks, the animal's body was divided into eighteen areas, not necessarily corresponding to the recognised anatomical regions (fig. 1):—1) Muzzle; 2) Periorbital zones; 3) Head (delimited by a vertical line drawn from the base of the ears ventralward over the throat latch but excluding 1 & 2); 4) Pinna's (both surfaces); 5) Ear passages; 6) Poll (including mane & upper neck border to withers); 7) Neck (lateral surfaces); 8) Dewlap; 9) Axilla (delimited by a line joining the points of the two shoulders cranially and by one running from one olecranon to the other caudally; 10) Sternum (caudal sternal and xiphoid regions up to the umbilicus); 11) Belly & groin (postumbilical and inguinal regions including udder/scrotum); 12) Lower perineum (ventral to vulva in the female or anus in the male to base of udder/scrotum); 13) Upper perineum (from base of tail, around anus, including vulva in the female); 14) Tail; 15) Tail brush; 16) Feet (below fetlocks); 17) Legs (from fetlocks to elbows/ stifles); 18) Rest of body (lateral thoracic, abdominal, gluteal and femoral regions).

Each of the sites was handled separately for the purpose of tick collections. The ear passage was carefully deticked by means of a fine spoon

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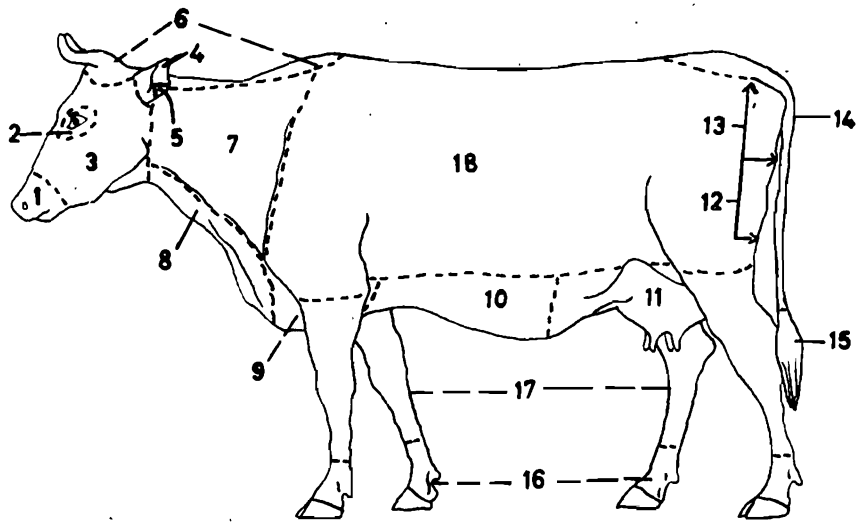

FIG.1. Sketch outline of individual sites of collection

curette. In the other sites, tick removal was accomplished by means of forceps for large ticks and a fine nit-comb for the other two stages of development. Each site was diligently combed, all hair, debris and ticks being collected into a specially adapted plastic funnel and thence transferred into separate and permanently marked plastic bottles. Each animal required some three and a half hours for complete deticking. The field collection bottles were then packed in specially constructed boxes and dispatched to the laboratory for further attention.

LABORATORY EXAMINATION

Initially, great difficulty was experienced in sorting the ticks owing to the large amounts of hair, debris and wax contained in the collection bottles. By placing each collection into a specially constructed 100 mesh stainless steel sieve and immersing the contents in boiling 10% NaOH solution for varying lengths of time, depending upon the amount of extraneous matter present, this difficulty was overcome and sorting and examination was greatly facilitated. Great care was exercised to ensure that the ticks were not overboiled, as this caused them to burst and made the task of identification well nigh impossible. After boiling, the sieve contents were washed into shallow 6″ diameter petri dishes. Due to the almost astronomical number of ticks encountered at times, a specially engineered divider for random sampling was used. The divider consisted of eight fine metal fins radiating from a central pin, which divided the petri dish into eight equal compartments. Two compartments were selected on the basis of a biometric random numbers chart and all ticks in these two compartments were sorted as to stage of development and numbers. The ticks were then identified microscopically as to species, sex and stage of development.

RESULTS

The total numbers and percentages of all ticks from the collection sites are presented in the table. The main predilection sites of cattle ticks in Natal, as established in this survey, are given in fig. 2.

INFESTATION OF INDIVIDUAL TICK SPECIES

Boophilus decoloratus:

The common blue tick is prevalent in all areas of Natal, including areas above 5000 feet; here it is found in relatively low numbers. This is a one-host tick, completing its life cycle within

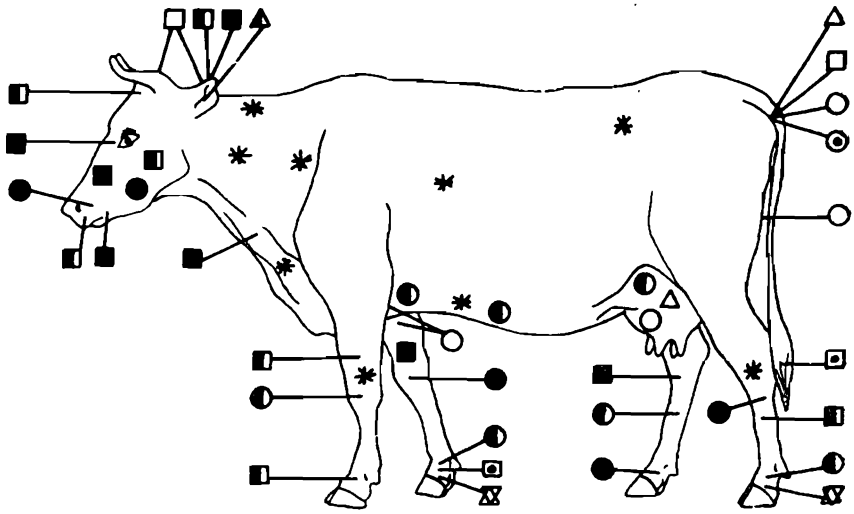

FIG. 2. Tick predilection sites

✱	B. decoloratus all stages	○	A. hebraeum adults
□	R. appendiculatus adults	◐	A. hebraeum nymphae
◧	R. appendiculatus nymphae	●	A. hebraeum larvae
■	R. appendiculatus larvae	⧖	R. tricuspis adults
△	R. evertsi adults	⊙	H. rufipes adults
▲	R. evertsi immatures	⊡	R. simus adults

three weeks, the larva moulting to the nymph and the nymph to the adult without changing position[3]. All references made to the blue tick include all stages of development. The main predilection of site for this species was the body, which harboured 24% of all boophilids collected from the calves. The legs, contrary to commonly accepted belief, where the next site of preference, bearing 13%. The neck (10%), poll (10%), dewlap (8%) and sternum (7%) were the remaining predilection sites bearing blue ticks in any numbers. Even when combined the neck and dewlap—the currently accepted preferred sites—only carried some 18% of the total burden.

The period of greatest activity fell within the month of November until the end of June. At high altitudes the tick was reduced in numbers, and completely absent during the remaining period of the year.

Amblyomma hebraeum:

The well known bont tick occurs in most thornveld and coastal areas of Natal. Its distribution apparently has spread since the zoological survey undertaken by Theiler[4]. The predilection sites for the adults are: belly & groin (45%), upper perineum (24%), lower perineum (15%) and axilla (15%). Adult activity started at the

TOTAL NUMBERS OF TICKS COLLECTED

Collection sites.	*B. decoloratus*	*A. hebraeum*			*R. appendiculatus.*			*R. evertsi.*		*R. simus*	*R tricuspis*	*H. rufipes.*
	(all stages)	Adults.	Nymphae.	Larvae.	Adults.	Nymphae.	Larvae.	Adults.	Immatures	Adults.	Adults.	Adults.
1. Muzzle	1,827 0.63%	1 0.06%	20 0.36%	1,477 18.08%	245 0.95%	5,436 7.31%	12,285 11.57%	— —	85 0.06%	— —	— —	— —
2. Periorbital zone	2,657 0.91%	— —	4 0.07%	261 3.20%	636 2.45%	2,211 2.97%	8,253 7.77%	— —	29 0.02%	1 0.14%	— —	— —
3. Head	14,081 4.84%	— —	20 0.36%	962 11.78%	460 1.78%	9,612 12.92%	12,464 11.73%	— —	105 0.08%	— —	— —	— —
4. Pinna	6,831 2.35%	— —	30 0.54%	475 5.81%	17,954 69.28%	18,104 24.34%	10,652 10.03%	— —	5,630 4.25%	— —	— —	— —
5. Ear passage	52 0.02%	— —	4 0.07%	1 0.01%	565 2.18%	343 0.46%	146 0.14%	1 0.02%	125,034 94.42%	— —	— —	— —
6. Poll	28,427 9.77%	— —	8 0.14%	145 1.78%	852 3.29%	7,420 9.98%	2,191 2.06%	9 0.16%	96 0.07%	3 0.41%	— —	— —
7. Neck	30,335 10.42%	1 0.06%	5 0.09%	120 1.47%	708 2.73%	5,071 6.82%	5,281 4.97%	1 0.02%	150 0.11%	— —	— —	— —
8. Dewlap	23,879 8.20%	11 0.66%	55 0.98%	648 7.93%	726 2.80%	3,686 4.96%	12,812 12.06%	— —	171 0.13%	4 0.55%	— —	— —
9. Axilla	12,214 4.20%	241 14.53%	540 9.67%	528 6.46%	246 0.95%	1,285 1.73%	2,844 2.68%	33 0.57%	14 0.01%	1 0.14%	— —	— —
10. Sternum	20,821 7.15%	68 4.10%	480 8.59%	336 4.11%	391 1.51%	1,935 2.60%	6,208 5.84%	20 0.35%	53 0.04%	12 1.64%	— —	— —
11. Belly & groin	17,729 6.09%	577 34.78%	378 6.77%	133 1.63%	389 1.50%	1,238 1.66%	2,409 2.27%	445 7.75%	32 0.02%	26 3.56%	— —	1 0.17%
12. Lower perineum	9,778 3.36%	250 15.07%	32 0.57%	35 0.43%	382 1.47%	283 0.38%	905 0.85%	23 0.40%	45 0.03%	6 0.82%	— —	7 1.18%
13. Upper perineum	607 0.21%	393 23.69%	7 0.13%	2 0.02%	1,195 4.61%	188 0.25%	119 0.11%	5,143 89.54%	338 0.26%	18 2.46%	— —	575 97.80%
14. Tail	9,114 3.13%	16 0.96%	16 0.29%	1 0.01%	262 1.01%	1,103 1.48%	1,031 0.97%	3 0.05%	188 0.14%	27 3.69%	2 1.63%	1 0.17%
15. Tail brush	614 0.21%	2 0.12%	184 3.29%	35 0.43%	67 0.26%	739 0.99%	186 0.18%	11 0.19%	15 0.01%	451 61.70%	5 4.07%	— —
16. Feet	4,366 1.50%	45 2.71%	3,500 62.66%	1,535 18.79%	103 0.40%	5,216 7.01%	5,575 5.25%	26 0.45%	145 0.11%	130 17.78%	115 93.50%	6 1.01%
17. Legs	38,002 13.06%	41 2.47%	284 5.08%	1,400 17.14%	336 1.30%	7,155 9.62%	18,551 17.46%	22 0.38%	89 0.07%	49 6.70%	1 0.81%	1 0.17%
18. Body	69,743 23.96%	13 0.78%	19 0.34%	75 0.92%	398 1.54%	3,359 4.52%	4,311 4.06%	7 0.12%	200 0.15%	3 0.41%	— —	3 0.51%
TOTAL	291,077 100.01%	1,659 99.99%	5,586 100.00%	8,169 100.00%	25,915 100.00%	74,384 100.00%	106,223 100.00%	5,744 100.00%	132,419 99.98%	731 100.00%	123 100.01%	594 100.01%

*From 2 calves on each of 4 farms.

beginning of September and declined towards the end of January.

The bulk of the nymphae were found on the feet (63%), followed by axilla (10%), sternum (9%), belly and groin (7%) and legs (5%). Nymphae were active from the beginning of May until the end of September.

Larvae showed no single predilection site, being found in almost equal numbers on the feet (19%), muzzle (18%), legs (17%) and finally head (12%). Activity was confined largely to the February to mid-May period.

Contrary to published records, cattle apparently play an important rôle in the maintenance of immature stages, a total of 159 nymphae and 727 larvae being recorded from one calf during the respective peaks of activity.

Rhipicephalus appendiculatus:

The brown ear-tick is found throughout the major portion of Natal at altitudes below 5000 feet. Above this altitude it is relatively scarce, possibly due to the extreme cold and/or lack of suitable vegetational cover.

The main predilection sites for the adult brown ear-tick was undoubtedly the pinna, some 69% of all ticks occurring in this site. The poll (3%) possibly carried the overflow from the pinna. The upper perineum (5%) was the next site of choice. The main adult activity occurred from mid-November until the end of March. Nymphae were found to be most numerous on the pinna (24%), then on the head (13%), poll (10%), muzzle (7%) and feet (7%). They were mainly prevalent from the beginning of April to the end of September.

The larval stages showed no specific predilection site, being found mainly on the legs (17%), dewlap (12%), head (12%), muzzle (12%), pinna (10%) and periorbital zone (8%). The peak of larval activity occurred from the beginning of February until the end of June.

Rhipicephalus evertsi:

The red-legged tick was encountered in large numbers in the lowveld areas of Natal, at altitudes below 4500 feet. At higher altitudes, progressively lesser numbers were collected. As this is a two-host tick, the larval and nymphal stages are collectively termed immatures. The main predilection site for the adult almost exclusively was the upper perineum, some 90% of all adult *R. evertsi* being recovered from this site. Peak adult activity occurred during the period from January to the end of May.

The undisputed predilection site for immature stages was the ear passage, a total of 94% being found in this area. Their numbers rose from early November, reached a peak in the summer months from January to April, and tailed off towards the end of June. Both adults and immatures were never entirely inactive, however, being collected in the remaining months of the year, although in lesser numbers.

A characteristic feature of this tick was the amazingly high number of immatures collected and the relatively low number of adults, the records showing a proportion of 100:4.3.

Rhipicephalus simus:

The glossy brown tick occurs over scattered areas of Natal, but never in any great numbers. Only the odd specimen was found at altitudes above 5000 feet. As the immature stages of this tick are found mainly on rodents[5], the occurrence of the adult stage only is recorded.

The tail brush (62%) and feet (18%) were the preferred attachment sites. Odd ticks were found on the legs and tail. Activity was at a peak from early August until the end of January, but this tick was never entirely inactive during the other months of the year.

Rhipicephalus tricuspis:

The tricuspid glossy brown tick is found in Natal at altitudes below 5000 feet, being most prevalent in the belt 2000 to 4000 feet, but never in any appreciable numbers. As the hosts of the immature stages in nature are unknown, only the adult stages are discussed.

The tick was located mainly on the feet (94%). The appearance of this tick was apparently closely related to the first spring rains. Wherever the tick occurred, it appeared approximately 2 to 3 weeks after the first rains, i.e. in mid-September, and was present until the end of December. For the remainder of the year this tick was entirely absent, except for an occasional appearance in late summer.

Hyalomma rufipes:

This bont-legged tick occurs in most thornveld areas of Natal, being absent from the mistbelt and highveld areas. Theilier[5] records that

the immatures occur mainly on ground birds and hares. As no records are available on the seasonal variation of the immatures, only the adults are discussed.

The adult tick occurred almost exclusively on the upper perineum (97%). Activity commenced at the beginning of November and tailed off towards mid-February.

Discussion

While plunge or spray dipping is an accepted practical means of tick control on cattle, investigations carried out in Australia[7] indicate that this is a costly process. Against those species of ticks with no preferred attachment site, thorough wetting of the entire body is essential to obtain adequate control. Against those tick species, which show definite sites of predilection in attachment to cattle during one or more of their developmental stages, a local attack could well offer a more suitable and economic means of control.

B. decoloratus shows no marked preference for a particular site, so that complete wetting of the body must be ensured to effect control. As it has a feeding period of 21—23 days[3], strategic dipping, i.e. dipping only during peak activity and that at 3-weekly intervals, could possibly prove an economical and practical means of control[8].

A. hebraeum, a three-host tick, is largely limited by climate in Natal to the thornveld areas. Whilst Theiler[5] records that the immatures occur mainly on birds, this survey indicates that large numbers of immatures occur on cattle (the limbs), in the proportion of 4.15 immatures to 1 adult. As adults are found almost exclusively on the bare parts of the animal—especially the axilla, belly and groin, sternum and upper perineum—and as the females engorge in 4 to 6 days, local spraying of these areas with a suitable ixodicide at weekly intervals during the period of greatest activity should achieve a considerable measure of control.

Neither the larval nor nymphal stage of *R. appendiculatus*, a three-host tick, showed any predilection site, but adults were found almost exclusively on the ear. Control is thus theoretically possible by a regular attack against the adult stage. The adult can engorge in three days, though more usually in 4 to 7 days[3], so that thorough dressing of the inner and outer surfaces of the pinna of the ears at weekly intervals with a selected acaricide in an oily or greasy medium should achieve successful control.

Both adults and immatures of *R. evertsi*, a two-host tick, had definite, preferred attachment sites. The immatures were found almost exclusively in, or on, the ear, and as they require about a fortnight for feeding[3], fortnightly dressing of the ear passages could achieve a high degree of control. Thus both *R. evertsi* and *R. appendiculatus* theoretically could be reasonably well controlled by regular weekly dressing of the ears of stock during the season of main activity of these ticks.

Only the adults of *R. simus*, a three-host tick, parasitise cattle and engorge in seven days on an average[9]. This study indicates that the adults occur mainly on the tail brush and feet. Clipping and wetting of the tail brush and the use of a walk-through trough at weekly intervals during peak periods could thus limit the incidence of this tick.

R. tricuspis, a three-host tick, is seldom a problem on domestic stock. Where indicated, the adult ticks may be controlled by the use of a walk-through trough at weekly intervals during peak activity, the adult engorgement period being from seven to fifteen days[9].

Where *H. rufipes*, a two-host tick with an adult feeding period of seven to fourteen days[3], is a problem weekly hand-dressing of the upper perineum during the period of greatest activity should control the tick population.

Plunge or spray dipping alone is generally accepted as being inadequate in that the fluid does not reach under the tail or the ear passage, nor does it penetrate the poll. Where there is a general tick problem such dipping must of necessity be combined with hand-dressing if tick control is to be achieved. One of the major problems is the short duration of effectivity of many of the presently used ixodicides, particularly where stock are exposed to adverse climatic conditions such as rain and mist, which tend to reduce the amount of the active substance at the site. This problem could be obviated to some extent by the use of an ixodicide in an oily or greasy medium; it is therefore recommended that, whenever control measures are to be im-

plemented against ticks at specific predilection sites, such as poll, ear and anal region, an oil- or grease-based preparation be used.

The study of the seasonal activity periods of the more important cattle ticks in Natal, viz. *B. decoloratus*, *A. hebraeum*, *R. appendiculatus* and *R. evertsi*, (which will form the basis of a separate report) shows that the main adult and larval activity periods fall approximately within the periods from November to the end of June. During the remainder of the year, activity is markedly decreased with the exception of *A. hebraeum* and *R. appendiculatus* nymphae, which are active until September. These findings indicate that a concerted effort to control ticks, both adult and larvae, during the period from January to the end of June, with little or no control measures during the rest of the year, may well prove a practical means of limiting tick infestation of cattle in Natal.

Acknowledgements

The Chief, Veterinary Field Services, is thanked for permission to publish this paper. We wish to thank Dr. Gertrud Theiler of Onderstepoort for all the help and encouragement given during the Natal tick survey, and all the laboratory and field staff charged with the often laborious task of collecting and sorting of the ticks.

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Jl S. Afr. vet. med. Ass. 38 (4): 454-455 (1967)

A FIELD TRIAL WITH VAGINAL SPONGES IMPREGNATED WITH 6-METHYL-17-ACETOXY-PROGESTERONE (MAP) TO SYNCHRONISE OVARIAN ACTIVITY IN MERINO EWES DURING THE BREEDING SEASON

K. M. VAN HEERDEN*

INTRODUCTION

The synchronisation of ovarian activity in ewes has been extensively investigated, particularly in Australia. Lamond[1] reviewed the results of methods using progesterone or its orally active derivatives. Practical application in sheep became possible when Robinson[2] reported the successful use of vaginal sponges impregnated with progestational agents which gave a high degree of synchronization and a fair conception rate. Roberts[3] reported on the success of using 60 or 80 mgm 6-methyl-17-acetoxyprogesterone (Map) during the breeding season.

The present study reports the results obtained from the use of 100 such sponges during the peak of the breeding season.

MATERIALS AND METHODS

Vasectomised rams with "sire-sine" harnesses were introduced into a flock of 100 ewes, all of which had raised lambs the previous season. Sponges containing 60 mgm MAP and coated with Cetrimide Cream** were inserted on 29.3.1966. After 13 days the sponges were removed from half of the ewes (group 1) and the remainder were removed on the 15th day (group 2).

Ewes marked by the rams were inseminated with 0.1 ml undiluted semen at 9 a.m. and removed from the flock. Those which came into oestrus later were hand served.

RESULTS

Forty eight ewes in group 1 and 50 ewes in group 2 showed oestrus within 72 hours of removal of the sponges. One of the ewes not reacting had lost the sponge and the other never came on heat subsequently. The numbers of ewes found marked by the rams at 24, 48 and 72 hours after removal of the sponges were 1, 29 and 18 in the first group and 2, 43 and 5 respectively in the second group. The number of takes at first insemination were 32 in group 1 and 30 in group 2.

Of the total 100 ewes, 68 lambed to A.I. and 20 to subsequent service. The figures for the groups are not available.

DISCUSSION

Better synchronisation and lambing percentages were obtained by Robinson[2] Shelton[4] and Hulet[5]. This may be because known fertile mature ewes were used at the height of the breeding season. Management was of a particularly high standard.

The signs of oestrus were more marked in treated than in untreated ewes.

A bad smell was noted on removal of the sponges. No pathogenic bacteria could be found[6].

The present recommendation in South Africa to remove the sponges on the 14th day is supported by this experiment.

* Veterinary Diagnostic Centre. Middelburg. C. P.
** Messrs. I.C.I. (Pharmaceuticals) Ltd.

Acknowledgements

Thanks are due to Dr. E. M. Roberts of Australia for supplying the sponges and the Chief, Veterinary Services for permission to publish in this journal.

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Jl S. Afr. vet. med. Ass. 38 (4): 456-457 (1967)

THE MERITS OF "PHOSTOXIN" IN THE ERADICATION OF SMALL *VIVERRIDAE*

I. F. ZUMPT* AND H. W. DE BRUYN**

SUMMARY

The effect of "Phostoxin"† on *Cynictis penicillata* (red or yellow meercat or mongoose) was tested in the field and under laboratory conditions. This inexpensive method of eradication was found to be effective but considered to be cruel.

INTRODUCTION

The control of rabies in a great part of South Africa[1,2] is aimed at the eradication of the chief vector, *Cynictis penicillata*, commonly known as the red or yellow mongoose or meercat, as well as of other members of the family *Viverridae* and *Geosciurus capensis*, the Cape ground squirrel. They all live in colonies consisting of numerous interconnecting subterranean burrows with numerous openings. Several methods of extermination have been used.[2]

In order to find a cheaper and more effective method, "Phostoxin" was tested. This volatile fumigant, available in tablet form, was developed by Degesch of Western Germany; each tablet contains 1gm aluminium phosphide as active ingredient. When in contact with moisture, it decomposes to liberate phosphine, a highly poisonous gas. An exposure time of three to five days is advocated by the manufacturers.[3,4,5]

This compound has been used for some years in the eradication of insects, mice, hamsters, moles, rock rabbits ("dassies"), gerbilles, springhares, porcupines, and other rodents[4]. "Phostoxin" has to be handled with great care, as in human beings signs of poisoning have been reported which include nausea, fatigue, oppression of the chest, headaches, stomach pains, cardiac and circulatory collapse.

EXPERIMENTAL PROCEDURES AND OBSERVATIONS

"Phostoxin" tablets, each containing one gram of active ingredient, were removed from the original container by means of a pair of forceps and introduced into the burrows of wild *Viverridae* with a long-handled spoon. All openings were immediately closed with sand or soil.

1. A colony consiting of eighteen single openings and measuring fifteen by ten yards in size was treated with three whole tablets placed into three holes equidistant from the centre of the colony. All openings were then closed. After seven hours the colony was dug up, and one dead and two live red meercats (*Cynictis penicillata*) were recovered. The latter two were placed in cages, and their behaviour studied until death. Both were semi-conscious when recovered from the burrow; they had no power in the fore-legs, showed abdominal respiratory movements, and made constant running or walking movements with the hind legs. One died two hours, and the other six hours after having been placed in the cages.

2. A second colony consisting of sixteen holes and measuring twelve by fourteen yards was treated with eight half-tablets. After sixteen hours the colony was opened and one dead meercat was recovered.

3. Two colonies of similar size to the preceding one were treated with half a tablet per five holes. When they were opened a day later, one live and two dead red meercats were found respectively.

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**Zoological Unit No. 5, Agricultural Technical Services.
† Distributed by Agro-Chem (Pty.) Limited.

4. Forty-five further colonies were opened one to three days after treatment and 112 dead meercats were recovered.

5. A survey was made to determine the intensity of colonisation on farms in the Mafeking area. This was found to vary from 0.1 to 0.3 colonies per morgen; each colony had 23 openings on an average.

6. When it was apparent that death was slow and painful, the following experiments were carried out to obtain further proof of these facts. An empty twenty-gallon drum was used. A red meercat was placed in this drum and observed for one hour. No abnormal signs of behaviour were noted. A third of a tablet was then placed in the drum, which was immediately covered with a tightly fitting plastic hood to prevent escape of the gas. After thirty minutes nothing abnormal was observed except occasional sneezing. The animal was then transferred to a cage. Three and a half hours later symptoms were noticed. These started with slight inco-ordination, aimless running about, fletching of teeth and intermittent fits of muscular spasm, gradually developing into paralysis of the fore-quarters. Running movements of the hind-quarters decreased until the animal was completely paralysed. It died in a state of dyspnoea six hours after onset of symptoms. The experiment was repeated using one tablet of "Phostoxin". Symptoms were identical, and the animal died three hours after onset thereof.

7. Specimens sent to the Veterinary Research Institute, Onderstepoort revealed the following histopathological changes: The liver showed hyperaemia and haemorrhages forming pools of blood similar to those seen in acute seneciosis. Severe fatty changes, mostly centrilobular, and necrosis of liver cells were also observed. Severe hyperaemia, isolated haemorrhages, and slight oedema were found in the lung. The heart muscle revealed small areas of necrosis. The brain and spleen were congested and the kidneys showed cloudy swelling.

Conclusions

In all cases "Phostoxin" caused the death of meercats, therefore this method of eradicating small *Viverridae* is effective. A dosage rate of one half tablet placed into every third hole is regarded as sufficient for this purpose. On this basis the cost will vary from 0.6 to 2 cents per morgen, which is minimal. The method of eradication is very simple and one person can cover a large area per day.

The symptoms observed in affected meercats indicate that this method is cruel and painful. If available, more humane methods should be used: "Phostoxin" cannot be advocated by the authors for this reason.

Acknowledgements

We wish to thank the Chief, Veterinary Services, for permission to publish this article.

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BOOK REVIEW

GRUNDRISS DER HISTOLOGIE UND VERGLEICHENDEN MIKROSKOPISCHEN ANATOMIE DER HAUSSÄUGETIERE.

Grau, H. and Walter, P. 1967., Paul Parey, Berlin and Hamburg.

Pp. 171, 154 drawings in text and 12 colour plates; price: D.M. 58.

With the publication of this book in German, students of histology are presented with the necessary subject matter in a brief and concise form. In an attempt to avoid lengthy descriptions and to present the basic facts in an easily absorbable form the authors have made ample use of well annotated illustrations, a number of which are original and in three dimensions. The quality and definition of the illustrations is of a high order except plate IV on the blood cells of domestic animals in which definition is rather poor.

The subject matter comprises a chapter on general and ultra-cytology, on the rôle of tissue fluid, a discussion of the four principal tissue types and then a review of the histology of all organs and organ systems. Cytological detail is mostly omitted while stress is laid on the fundamental aspects and species differences.

This book is excellently compiled and in addition should serve as a useful summary, even for postgraduate students. It is a welcome addition to a rather limited number of publications on animal histology. An English translation should be seriously considered.

W.H.G.

Jl S. Afr. vet. med. Ass. 38 (4): 459-461 (1967)

BOOK REVIEW

TEXTBOOK OF THE SPECIAL PATHOLOGICAL ANATOMY OF DOMESTIC ANIMALS

Karl Nieberle and Paul Cohns (revised by P. Cohrs).

Translated by R. Crawford

First English Edition, Pergamon Press, London, 1967 · Pp. 1027. 727 Illustrations. £10.10s.

This classical German tome on morbid anatomy, which has for so many years been the standard textbook for veterinary pathology in German-speaking countries and an oft-used reference for graduate students with a reading knowledge of that language, has been translated into English at last. For this, veterinarians owe the translator a well-earned debt of gratitude.

This book in German was unchallenged as a veterinary pathology text for so long that one is hesitant to offer any criticism of the present edition. Instead there is a temptation to stress the many excellent attributes of the edition and inject here and there a number of comments which should be interpreted as constructive criticisms.

The subject matter is presented in twelve segments labelled with general headings. Under the appropriate heading, the systems of the body are covered, organ by organ. For each there are subject breakdowns as follows: post-mortem changes, malformation, disturbances of metabolism, circulatory disturbances, general and specific inflammations, tumors and parasites.

This format greatly facilitates the location of the available information concerning specific lesions which are encountered in the course of post mortem examinations. It is not without some disadvantage, however, as some diseases affecting several systems are thus discussed, in some instances, in widely scattered portions of the book. This necessitates an extensive search should all the information about the entity be desired, and often continuity on the subject is totally lacking. This is greatly outweighed, however, by the many advantages offered by this format.

The many illustrations (727) are, generally, very adequately engraved and printed on a good grade of high quality paper which is used for the attractive typography throughout, as well. Illustrations are advantageously placed through the text in a way that pleasantly breaks the potential monotony of endless pages of print. Pictures of the gross lesions have been chosen particularly well and considerable space has been economized by limiting the sizes of the prints used to that which is adequate. Unlike the way it appears in the case of some other textbooks, there has been no attempt to see how large a print could be placed on a page when perhaps one half the size would show the same subject matter sufficiently. This practice must have saved considerably on the cost of producing the book. Many of the gross lesions are illustrated by black and white drawings which are most effective in depicting that which was intended. Though limited in number, some gross lesions are shown in colour. Most were well chosen and the colour reproduction is reasonably accurate for the majority. A few, however, are disappointing and perhaps should have either been omitted or replaced by better pictures in colour or by good black and white prints.

Many of the illustrations of microscopic lesions, including some in colour, are drawings. Any pathologist who has tried to illustrate such lesions with photomicrographs, either for exhibits or publications, will appreciate how effective these drawings are in demonstrating lesions with a minimal amount of space. Photomicrographs are also used but primarily make a less impressive showing than the drawings. Readers will be grateful for the labelling of the photomicrographs and drawings which is neatly done by placing the letters on the white borders

surrounding the illustrations with unbroken lines leading to the points which are dealt with in the captions containing the corresponding letters. In this position the letters are easily located at a glance, thus obviating the necessity of searching for them superimposed somewhere on the illustration.

The author and publisher have obviously quite often compromised on the size of type used in the text. A considerable portion of the book is in rather small print. This permitted the inclusion of an extensive amount of information which might otherwise have been left out unless the book had been enlarged even more than it has been. The small print contains the more detailed descriptions for which those who really desire the information would gladly use a magnifying glass if necessary—but which it isn't.

Specific references to the literature for documentation of statements in the text are relatively few. Where there is only one reference coming after a short resumé of a disease entity, it can, of course, be assumed that the information was contained in it but there may be more than one. References are conveniently placed at the end of the paragraphs and/or pages where a particular subject is discussed. Though one can count an excess of twelve hundred references in the book, it is doubtful if it will be considered an outstanding source of references. It pales considerably by comparison in this one aspect with some other veterinary pathology books in English. In many instances, only the author's name and publication year are given as documentation for statements with no indication of the specific reference available elsewhere. In most instances, however, the author, the name of the journal and either the volume or year of publication are available. In some of those which were obviously added with this revision, page numbers are also included. Titles of the articles are not given and without question there will be severe criticism from some quarters for their omission in the references. It must be remembered, however, that this book is already "bulging at the seams" with information and that limitation of space no doubt was an important influence in this decision. Perhaps a solution to this eternal problem lies either in a library service which will provide titles of specific articles promptly at a reasonable fee or a universal agreement by all authors, editors and publishers that the title will always be included in all references. It is obvious that the authors did not plan for it to be an outstanding source of references.

This textbook is particularly thorough in its coverage of tuberculosis. Approximately eighty pages (about 8% of the total number) are used in the text by the discussion and illustration of lesions of tuberculosis. If there is anything left out about the pathology of tuberculosis in domestic animals, it must not be worth discussing. It is quite apparent that the writer draws on a wide and profound base of knowledge and experience with regard to this and most other disease entities. Because of this, it has to be considered to be an important reference book. The tendency of some authors to dwell on subjects with which they are most familiar can be observed in this one, as well, but this is to the reader's advantage because the author seems to be "most" familiar with a great many subjects and writes about them quite authoritatively. That there is material which could have been condensed is also apparent if judged on the contemporary applicability of such information. There has been appropriate emphasis on the appearance of gross lesions viewed with the unaided eye. As with many revisions, there have obviously been few subtractions but additional material is prominent in many places. In a considerable number of instances new material has been added in a very brief manner with scant information provided on the subject. These token supplements or "mini-abstracts" of articles detract from the sound, judicial presentation of the material elsewhere throughout the book. Such subjects will no doubt be more thoroughly dealt with in future editions and better assimilated along with others. Some subjects which might be considered somewhat esoteric are given rather extensive coverage while more important ones from the standpoint of economic importance, are to some degree, slighted.

From the standpoint of the veterinary pathologist and other veterinarians concerned with disease of domestic animals in Southern Africa, this book joins the other pathology texts in the habit of almost ignoring many of the important diseases present here. This is no doubt because of the limited experience of the several authors in regard to diseases from this part of the world. It is also regrettably due to the fact that the pathology of many of them has not been ade-

quately dealt with in the literature. Until such gaps are filled in our veterinary literature and in the textbooks on veterinary pathology, through an immense amount of hard work by experienced pathologists thoroughly familiar with these entities, there will remain serious deficiencies in the spectral aspects of veterinary pathology. Many of the other conditions which are found here as well as elsewhere in the world are expertly covered; therefore, one working here can still benefit immensely from the book.

Having heard so much about the exalted verbosity of the German tomes with "never-ending" sentences and innumerable phrases, the reviewer was pleasantly surprised by the modest length of the sentences which was accompanied by an excellent sense of punctuation. This revision as well as previous alterations have in some places made the presentation of material a bit choppy, with frequent changes from one short paragraph to another paragraph about a totally different disease entity. Except for these very obvious abridgements, the text is written in a lucid and interesting style.

The index leaves a lot to be desired in that the book is poorly indexed compared to some other veterinary pathology texts, but infinitely better than still others. Errors of omissions and incompleteness in the index can be overlooked since it is the first English edition. For the same reason, typographical errors resulting in misspelled words in the text can be forgiven.

The hope is expressed by the author that this will not be regarded merely as a textbook for students but that it should serve them well in their future rôle of choice as veterinarians. If this was the reason for the author's writing the book, the endeavour has been a success because it will certainly serve both purposes well. There can be no question as to why past editions were so popular and the present one is sure to swell the ranks of admirers of this book.

As one must expect from a book of its size and quality, it is not inexpensive; nor is it unduly expensive in this age of inflation. For the person who is willing to make the investment of applying himself mentally after making the initial monetary investment, the transaction is sure to pay good dividends. It will no doubt become one of the most widely used veterinary pathology texts for the rest of the world now that it has been translated. It is a must for the veterinary pathologist and for those who aspire to do research in veterinary pathology, as well as for research workers in other disciplines of veterinary medicine. It will be especially useful for those engaged in diagnostic work based on the performance of necropsies daily. This includes those diagnosticians and veterinary husbandrymen who are involved with the common laboratory animals and poultry. The coverage of those poultry diseases which are included is excellent. Neither will its use be limited to the veterinary profession. Every medical pathologist should have it available for consultation because of its value in the arena of comparative pathology. Oral pathologists will, for the same reason, find it useful and its extensive coverage of the diseases of animal teeth will enhance its utility for them.

The reviewer feels that if the previous German editions were as informative as the present English one, then it is most unfortunate that the translator, Dr. R. Crawford, did not undertake the "onerous task of translation into English", as the author puts it in the preface, at a much earlier date.

R. M. McCully.

MINUTES OF THE SIXTY SECOND ANNUAL GENERAL MEETING HELD IN THE ATHLONE GARDENS HOTEL ON WEDNESDAY, 4TH OCTOBER, 1967, AT 8.00 A.M.

PRESENT

Dr. A. F. Tarr (President)
Dr. L. W. van den Heever (Vice-President)
Mr. S. Burger (Secretary)
and the following members—

L. Abrams; P. J. S. Anderson; M. A. J. Azzie; C. W. A. Belonje; G. H. R. Bisschop; J. H. R. Bisschop; P. J. Bisschop; P. P. Bosman; J. G. Boswell; H. J. W. Botes, P. A. Boyazoglu; C. M. Breytenbach; S. D. Cilliers; D. G. Clow; D. Coles; P. N. Collier; A. Combrink; R. Coubrough; S. A. Craig; G. C. Dent; J. M. de Wet; J. L. Doré; F. B. W. Du Casse; H. Ebedes; W. J. Ehret; J. M. Erasmus; A. E. Fair; J. R. Frean; W. E. Galpin; M. M. Greathead; H. Hellig; W. B. Hobbs; I. G. Horak; B. M. Horwitz; P. J. Howell; B. Irvine-Smith; B. C. Jansen; D. J. Jarvie; C. B. K. Jones; C. v. N. Jonker; P. Kieviet; E. Krog; C. A. Kronsbein; M. C. Lambrechts; D. J. le Roux; B. W. J. Lloyd; A. J. Louw; A. M. Lubbe; C. H. B. Marlow; J. H. Mason; M. J. N. Meeser; C. M. T. Meldal-Johnson; A. J. Morley; J. M.O'Grady; D. E. Osbourn; B. H. Pappin; J. R. Philip; J. W. Pols; H. S. Purchase; G. P. Retief; R. K. Reinecke,; C. B. Rippon; L. W. Rossiter; R. C. Rous; A. M. A. Schmidt-Dumont; D. K. Shone; A. J. Snijders; N. C. F. Steenekamp; H. P. Steyn; H. F. Strydom; R. D. Sykes; M. Taylor; H. J. J. Terblanche; A. R. Thiel; G. E. Thompson; J. A. Thorburn; P. W. Thorold; R. B. Trengrove; S. G. Turner; R. C. Tustin; P. L. Uys; W. P. van Aardt; K. van der Walt; A. van Heerden; K. M. van Heerden; W. W. van Heerden; C. H. van Niekerk; J. van Niekerk; O. T. van Niekerk; G. F. J. van Rensburg; S. W. J. van Rensburg; I. van Schalkwyk; L. von Maltitz; P. P. C. Wacher; A. C. Wellington; T. C. W. Wessels; W. J. Wheeler; J. G. Williams; R. A. Wilson; I. F. Zumpt.

APOLOGIES

C. F. B. Hofmeyr; T. F. Adelaar; J. J. Oberholster; A. B. la Grange; L. Hay; W. J. Ryksen; P. J. Meara; H. H. Kleeberg; C. H. Flight; D. G. Steyn; M. de Lange.

DEATHS

The President referred to the deaths of the following members:

T. Martinaglia; G. McIntyre; R. Paine; J. H. Schoeman; T. Threlkeld; J. K. G. van Zyl and Mrs. N. Meeser (late wife of Dr. M. J. N. Meeser).

He asked members to stand in silence for a minute as mark of respect.

1. CONFIRMATION OF THE MINUTES OF THE 61ST ANNUAL GENERAL MEETING

Notice of the meeting was taken as read and minutes of the 61st Annual General Meeting confirmed.

2. MATTERS ARISING FROM THE MINUTES OF THE 61ST ANNUAL GENERAL MEETING

(*a*) *Branch representation at Council Meetings.*

The President reported that no definite opinion can be given at this stage and suggested another year's trial. Dr. Steyn emphasized the necessity for branch representation and suggested a change of the present constitution at the next annual general meeting to regularise branch representation at Council Meetings.

(*b*) *Resolutions*:

Resolution No. 1.

Although the agricultural lay press was provided with information considered of interset to the farming com-

munity, it never appeared. The meeting agreed that the necessary steps be taken to establish a proper liaison service and the matter was referred to Council.

Resolution No. 2.

As the proper control in the importation of livestock, poultry, birds, and animal products is receiving Field Veterinary Services' very serious attention, the existing situation was noted with satisfaction.

PRESIDENTIAL REPORT

"Ladies and Gentlemen,

In spite of many difficulties with which we had to contend, the past year may be regarded as one of satisfactory progress within the association. During the year our Secretary Dr. Ryksen resigned and this brought about some delay in dealing with our normal activities. We were very fortunate however, in being able to call upon our old friend and stalwart Prof. Schalk van Rensburg. When I say old, I refer more specifically to his wisdom and experience and service to the association. On your behalf I now wish to record in appropriate manner our grateful appreciation to him. We now have a full-time secretary in the person of Mr. Schalk Burger whom I now formally introduce to you. Since his appointment a few weeks ago he has already achieved wonders and in welcoming him to our organisation we wish him well and trust that his sojourn with us will be a long and happy one.

Council Meetings.

During the year your Council met six times while the various sub-committees met on numerous occasions. This is an opportune time to express our gratitude to those members who devote so much of their time and energies in the interests of the association. I am always amazed at the unselfish service rendered often at considerable inconvenience. Attendances at Council meetings have with one or two exceptions been excellent. The exceptions give cause for concern and call for comment. We are all of us busy men but if we accept office then it is our unqualified duty to comply with the obligations of that office. If we cannot, then we must make way for someone who is able to serve the association. This is an obligation to the members and there is no need for me to stress the importance of well attended Council Meetings. I would like to suggest, that in future, when voting papers are sent out, the record of attendances at Council meetings be indicated for the guidance of members. This is not a new idea—it is practised by other organisations.

Council Membership and Committees.

At our last A.G.M. it was agreed that the various branches be represented on Council. This has now been put into effect but it will not be possible to express a definite opinion until next year. The branches have now all held their meetings and the idea of representation explained and accepted. Regional representation is in my opinion an excellent idea and I trust that it will prove successful. This is an invaluable way of keeping the whole profession informed on association matters. The greatest obstacle is the question of travelling expenses.

In the past we have considered the question of electing two Vice-Presidents. I think this is a sound idea and I would like to see it implemented.

Since our last meeting an Executive Committee has been appointed to deal with any urgent matters not requiring the attention of full Council. This has worked very well during the year and will I trust be recognised as a permanent committee.

Since 1946 all the Presidents of the association have been resident in Johannesburg or Pretoria. You will appreciate therefore that it has not always been possible for me to do as much as I would have wished. I have attended all Council meetings and many Committee meetings. Your Vice-President has deputised for me on many occasions and I wish to express my sincere thanks to him and all other Council members for all their help to me.

Coat of Arms

This matter was referred to you last year and you now have the completed shield before you which you will agree is a work of

art. The history of our Coat of Arms is fascinating and for the benefit of those who are interested I have extracted the necessary details from old journals.

Membership.

Our membership now stands at an all time high of approximately 550. During the year 38 new members joined the association. The alacrity with which new graduates join the association is a pleasing and healthy sign.

It is with regret that we have to record the deaths of 6 members referred to earlier. There were two resignations.

While dealing with membership I would appeal to all our colleagues to collaborate with one another to the full. We enjoy a high esprit-de-corps. Let us maintain this at all costs and never fail to appreciate one another's values and needs. In an organisation which is rapidly diversifying there will naturally be differences of outlook and opinion—it would be a sorry state of affairs if this were not so. Let us however respect one another's opinions and strive for the ultimate good of the association even though at times we may feel impatient and rebellious. Your Council is the official organ of the association and needs your loyal steady support. In an organisation such as ours, all decisions once debated democratically and resolved should be supported punctiliously and conscientiously if not enthusiastically.

Finance.

This will be dealt with during the course of the meeting but it is my duty to refer again to the large number of unpaid subscriptions. The amount outstanding is R1,585. An earnest appeal is made to members to pay their subscriptions promptly.

Branch Meetings.

During the year I attended the Annual General Meetings of four branches. I was very impressed with the attendance at these meetings and the enthusiasm displayed and it was a privilege and a pleasure to be present.

Important Issues.

The Committee investigating national veterinary matters has now completed its deliberations and the memorandum is now more or less ready for submission to the Marais Committee. Our thanks are due in particular to Dr. H. P. Steyn for his untiring efforts.

During the years Drs. Steyn and van den Heever interviewed the Deputy Minister (Agricultural Technical Services) in connection with the Animal Slaughter and Hygiene Act with very satisfactory results.

The Committee dealing with the Ethical Code has formulated new proposals for the attention of this meeting.

Editorial Committee.

I wonder how many of us appreciate all the hard work that goes into the printing of our journal? On your behalf I wish to record our very sincere thanks to Professor Clark and his committee.

And that, Ladies and Gentlemen, concludes my report for the year. The points I have raised and other activities engaged in during the year will be fully dealt with during the course of the meeting under their appropriate headings.

And finally, I wish to thank your Vice-President, Council members and all colleagues for their support and co-operation during the year".

Following this report, Dr. Steyn expressed a particular word of thanks to Prof. J. H. R. Bisschop for his unending efforts to serve the profession. He then requested the secretary to obtain an official translation of the Association's motto.

4. THE VETERINARY FOUNDATION

The Chairman of the Foundation, Dr. H. P. Steyn, reported little progress, during the past year due to various unavoidable circumstances but assured members that a more constructive report can be expected at the end of the next financial year.

5. MEMBERSHIP

(*a*) *Deaths.*

Drs. G. Martinaglia, G. McIntyre, R. Payne, J. Schoeman, T. Threlkeld, J. K. G. van Zyl.

(*b*) *Resignations.*

Drs. A. L. de V. Pienaar, G. Muller, A. V. May.

(*c*) *New Members*

The following were proposed and accepted:

S. O. Becker; R. D. Bigalke; L. Black; G. W. Burroughs; P. J. Fourie; S. Herr; P. A. Hughes; E. R. Jacobs; C. B. K. Jones; J. J. Jordaan; J. P. J. Joubert; L. I. Kann; A. E. Kritzinger; B. W. Lloyd; L. J. Loots; W. M. H. Löwe; G. J. G. Luyt; J. H. Malan; J. Marais; J. L. Möller; D. G. Mordant; A. J. Morley; J. M. Olivier; J. R. Payne; W. A. J. Peters; C. Irvine-Smith; J. M. Schmidt; G. L. Somerwill; A. Theodoridis; G. R. Thomson; P. van Aarde; I. B. van der Westhuizen; R. van der Westhuizen; H. H. van Niekerk; J. van Staden; W. J. A. Venning; M. J. Versfeld; P. Wissekerke.

(*d*) *Cadet Membership.*

Mr. J. S. C. Cullen was proposed and elected.

(*e*) *Hon. Associate Membership.*

The election of Prof. D. R. Osterhoff was duly proposed and seconded and unanimously accepted by the meeting.

(*f*) *Hon. Life Vice-Presidents.*

The election of Prof. J. H. R. Bisschop and Dr. H. P. Steyn was duly proposed and seconded and unanimously accepted by the meeting.

6. NOTIFICATION OF ELECTION OF OFFICE BEARERS FOR 1967/68

The election of Dr. Steyn as Hon. Life Vice-President resulted in five vacancies and the following members were elected:

Dr. J. M. M. Brown
Prof. C. F. B. Hofmeyr
Prof. B. C. Jansen
Dr. P. H. le Roux
Dr. I. van Schalkwyk

The new Council therefore consists of:

President	Dr. A. F. Tarr
Vice-President	Dr. L. W. v.d. Heever
Elected Members	Dr. J. M. M. Brown
	Dr. J. D. W. A. Coles
	Dr. M. de Lange
	Prof. C. F. B. Hofmeyr
	Prof. B. C. Jansen
	Dr. M. C. Lambrechts
	Dr. P. H. le Roux
	Dr. I. van Schalkwyk

7. CONSIDERATION OF FINANCIAL REPORT

(*a*) *Finance*

The chairman of the finance committee, Dr. S. W. J. van Rensburg, reported an excess of income over expenditure of R617.99. This figure is less than the previous financial year's but is largely due to a larger amount paid out to salaries and a loss of R422.01 on the Journal.

After obtaining legal advice finance committee advised Council to adhere to a strictly conservative investment policy and not to expose the Association's funds to any unnecessary financial risks. Council will thus continue its present policy to invest in giltedged securities only e.g. registered government or local stock.

The report was then adopted.

On a proposal by Dr. M. A. J. Azzie, it was unanimously agreed that members be supplied with Bank Stoporders to ease payment of membership subscriptions.

A suggestion by Dr. I. van Schalkwyk that membership fees be raised progressively, was referred to Council for further investigation.

8. WORLD VETERINARY ASSOCIATION

Prof. Jansen reported briefly on the proceedings at the World Veterinary Association's Conference and the meeting of the Permanent Committee of the World Veterinary Association in Paris.

The next World Veterinary Congress will be held in Mexico City in 1971.

9. REPORTS OF STANDING COMMITTEES

(a) *Committee investigating veterinary affairs—Marais*

Dr. Steyn reported that the committee has drawn up a memorandum broadly reviewing the present conditions of veterinary services but has still to make the necessary recommendations.

A letter has been sent to the Minister of Agriculture informing him that this memorandum will go beyond the terms of reference of the Marais Commission and requesting his guidance as to the proper procedure to be followed with such a memorandum. No reply has yet been received.

(b) *Committee of investigation into the purchase of milk.*

Dr. van den Heever reported that this committee was appointed by the Minister to investigate, amongst other things, the possibility of purchasing milk on a quality basis but, although considerable progress has been made, the committee has not yet finalised its deliberations. As soon as available a detailed report will be submitted to the S.A.V.M.A.

(c) *Animal slaughter, meat and animal products act.*

Dr. Van den Heever reported that provision has now been made in the act for the Chief Meat Hygiene Officer, exercising control over the implementation of the new act, to be a veterinarian.

With this new act the central responsibility for meat hygiene control will no longer fall under the Department of Public Health but has been handed over to the Veterinary Division of the Department of Agricultural Technical Services.

(d) *Ethical code.*

(i) An *Ad-hoc* committee was appointed to investigate the question of advertising with regard to the present development of veterinary hospitals and clinics. Their deliberations confronted them with the problem of defining a hospital, a clinic and a consulting room. The advisability of introducing a category "consulting rooms" is as yet an open question.

A referendum will be held in the course of the year giving members a chance to voice their opinions on all aspects of this matter and the result will be submitted to the 1968 Annual General Meeting for a final decision.

(ii) A request by Prof. Jansen that members be asked to furnish the Veterinary Board with what they regard to be the acts pertaining to to the veterinary profession, brought about a lively discussion and it was decided to refer the matter to Council.

(e) *Salaries of Municipal veterinarians.*

A memorandum was submitted to the Secretary for Health with a request for an interview to discuss various problems pertaining to this memorandum. On receipt of his reply that such negotiations would serve no purpose, a second memorandum together with another request for an interview was submitted and despite a number of reminders no reply has yet been received.

Council will continue to give the matter its serious attention.

(f) *The Name: S.A. Veterinary Medical Association.*

After a thorough discussion the following resolution was submitted by Dr. H. J. J. Terblanche and approved by the meeting.

„Die 62ste Jaarvergadering van die S.A.V.M.V. versoek hiermee sy raad om die nodige stappe te neem tot die moontlike verandering van die naam van ons vereniging na S.A.V.V. (S.A. Vereniging van Veeartse) S.A.V.A. (S.A. Veterinarian Association) en dat die professie se gevoel ingewin word by wyse van referendum of andersins sodat hierdie aangeleentheid by die volgende algemene jaarvergadering beslis kan word".

(g) *Women's Veterinary Auxiliary.*

The wives of members of the association are contemplating on founding a branch of this world movement in South Africa, the primary objective being to promote the interest of the wives of veterinarians and the profession as a whole.

(h) *International Students' Congress.*

The President reported that during the past year Council contributed R200 out of the Major Brown Prize Fund towards the expenses of Mr. Henry du Preez who attended this Congress in Paris, France.

(i) *National Council for Health Education.*

An application for foundation membership for the S.A.V.M.A. has been submitted because of the public health aspects which this particular organisation will deal with. As this is a new development nothing final can yet be reported.

(j) *Proposed control of veterinary practice in residential areas.*

Dr. Doré briefly outlined the difficulties veterinarians are experiencing in establishing veterinary practices in residential areas because of the discouraging attitude of local authorities together with certain new bylaws and regulations.

The President assured the Meeting that the matter is receiving the necessary attention of Council.

(k) *Military Veterinary Unit.*

In the absence of Prof. C. F. B. Hofmeyr no report was presented.

(l) *Attendance at Council Meeting.*

This was dealt with by the President in his Chairman's report.

9. GENERAL

(a) *Isolation of cases of rabies.*

Dr. Thiel asked for the establishment of some form of isolation for the suspect cases of rabies. An active discussion followed but no decision was taken.

(b) *Standardised regulations for kennel shows.*

Dr. Sykes submitted the following resolution and after being duly seconded, it was unanimously approved by the meeting:

"That the South African Veterinary Medical Association approach the South African Kennel club with the view to standardisation of procedure for examining animals at championship shows and also to reach agreement on which diseases should be excluded from such shows".

(c) *Refresher Courses.*

Prof. Jansen indicated the necessity for some kind of refresher courses. After being fully discussed, Prof. Jansen proposed that the matter be referred to Council for further investigation.

The proposal was duly seconded and approved by the meeting.

(d) Dr. Steyn expressed a hearty word of thanks and appreciation towards the members of the association for the contribution presented to him and his wife when he left the chair at the end of 1966. Out of this presentation, a sum of R300 was donated to the association's benevolent fund.

(e) Dr. G. Bisschop raised the following points:

(i) The release of new drugs must be announced to veterinarians at least two weeks in advance. Prof. Jansen suggested that the drug firms be approached by the South African Veterinary Medical Association with a request to this effect.

(ii) What the position was regarding the rebate offered to drug firms on the purchase of Onderstepoort vaccines. Prof. Jansen explained that drug firms, providing a bank guarantee and adhering to certain minimum sales conditions, receive a rebate of $33\frac{1}{3}\%$ on Onderstepoort vaccines. Veterinarians receive a $12\frac{1}{2}\%$ rebate.

(iii) The question regarding the role of drug firm representatives in the testing of manure samples was answered by dr. H. J. J. Terblanche who explained that representatives will under no circumstances be allowed to do the actual testing and any form of supersession is closely watched by the Veterinarians in industry.

(*f*) Dr Steyn moved the adoption of the following two resolutions:

(i) "That trade representatives and other non-guests in future be informed that their presence is welcome and that they are free to listen to the proceedings of this congress but not to take part in any of the social functions or scientific deliberations without specific invitation".

(ii) "That council investigate the possibility of denying false advertising material. This might best be handled through the Registrar of Remedies".

Both resolutions were duly seconded and unanimously approved by the meeting.

(*g*) The following resolution submitted by the President was duly seconded and approved by the meeting.

"That, at the next Annual General Meeting, the constitution be amended to make provision for the election of a second vice-president".

10. VENUE OF 1968 CONGRESS

The meeting decided that the next congress be held at Onderstepoort. Dr. Horwitz, on behalf of the Cape West Branch invited the Association to Cape Town for the next Congress to be held outside Onderstepoort.

11. ADJOURNMENT

Before adjourning the meeting, the President referred to the death of Major D. B. J. McCall and asked members to stand in silence for a minute as mark of respect.

The meeting was formally declared closed at 12.45 p.m.

MINUTES OF THE 14TH ANNUAL GENERAL MEETING OF THE CAPE EASTERN BRANCH OF THE S.A.V.M.A. HELD AT EAST LONDON.

5th August, 1967.

Present: Dr. G. Thompson (Chairman), Drs. van Heerden, van Tonder, Buchalter, Lambrechts, Flight, Leeb-du Toit, Watt, Fick, Osrin, Burroughs, Botha, Immelman, Richardson, Hart, Rippon, Galpin, van der Westhuizen, Krog, J. A. L. de Wet, Tarr, Roos, Erasmus, Malan, Dent and visitor Jones-Davies.

Apologies: Drs. J. M. de Wet, Dovey, van der Veen, Jonker, Burton, Schutte, van der Vyver, P. Botha, Hart, Rossiter, Stampa, Williams-Jones.

New Members: The following were proposed and accepted as new members of the branch: Drs. J. A. L. de Wet, van der Westhuizen, Watt, Richardson, Deacon and Krog.

Minutes of the 13th A.G.M.: These were published in the Branch's bulletin, UGQUIRA, and were taken as read. There were no matters arising out of the minutes.

Financial Report: This was read by the Secretary and accepted. The Book Fund stood at R46-87., and that during the past year it had been dormant. The General Fund stood at R74-50.

Chairman's Address: Dr. Thompson delivered his address, and it was decided that it should be published in the bulletin.

Election of Office Bearers: The following were re-elected, having made themselves available for re-election. There were no other nominations for these offices.

Chairman: Dr. G. E. Thompson

Additional Members:

Dr. R. Buchalter

Dr. J. Fick

The retiring Secretary, Dr. E. Leeb-du Toit, was not available for re-election, and Dr. I. S. Watt was elected as the new Secretary. Dr. J. M. de Wet as Assistant Chief (Field) is Ex Officio a Member.

Next A.G.M.: It was agreed that the venue again be East London, and that the date be the first Saturday in August, 1968.

Representation on Council: Dr. Thompson opened the discussion, and pointed out that some of the other regional Branches were represented on the Council already, and that each Branch was entitled to representation on Council. Council, however, do not want Branches to make use of proxies, and stressed the fact that the same person should represent his Branch at each meeting during the year. Dr. Lambrechts elaborated, and pointed out that Council was not at present representative of the profession as a whole, but of only the Pretoria and Witwatersrand veterinarians. The remedy for this lay in each branch having representation on Council.

The representative would be required to attend about four meetings a year in Pretoria. This would involve an approximate cost of R40 per trip for the fare. At present the Branch could not afford this unless we increased our subscriptions as the South West African and Western Cape branches had done. The meeting agreed unanimously to increase the annual subscription by R4 to R5-00 per annum with effect from this year.

Dr. Thompson was unanimously elected as the Branch's representative on Council and he thereupon expressed his intention to carry out to the best of his ability the task entrusted to him.

PROFESSIONAL INDEMNITY INSURANCE: Dr. Leeb-du Toit initiated a discussion on this subject and expressed concern that the Veterinary profession experienced difficulty in obtaining this form of insurance. He proposed that Council should look into this matter and possibly find a means of providing such insurance. Dr. Marlow pointed out that it was against legal expenses incurred in an action that insurance was required. Dr. Tarr informed the meeting that the Yorkshire Insurance Co. was prepared to underwrite a professional indemnity policy for veterinarians. In view of this information, Dr. Leed-du Toit then withdrew his proposal.

GENERAL: Dr. Marlow proposed that the following resolution be laid before Council: This 14th Annual General Meeting of the Cape Eastern Branch of the S.A.V.M.A. views with concern the weakening of the State Veterinary Services. The steady loss of valuable personnel indicates that conditions in the State Service are not acceptable to the profession. The profession as represented by Council should take all steps necessary to rectify the position.

The meeting thereupon agreed that this resolution be forwarded to Council. There being no further business under General, the meeting then closed, and proceeded to the scientific meeting, which was opened by Dr. Tarr. An informative programme of papers brought enjoyment and enlightenment to all.

The proceedings closed with an enjoyable party at the residence of Dr. & Mrs. Thompson.

MINUTES OF THE 12TH ANNUAL GENERAL MEETING OF THE SOUTH WEST AFRICA BRANCH OF THE S.A.V.M.A. HELD IN WINDHOEK ON 21ST SEPTEMBER 1966.

PRESENT

Drs. H. Halenke (chairman)
A. Lorentz
H. Schneider snr.
H. Ebedes
E. L. Redelinghuijs
R. B. Bilbrough
J. A. van Wyk
A. Combrink
H. Schneider jnr.
W. W. van Heerden
J. Joubert
D. de Lange
J. S. Watt
J. H. B. Viljoen
W. H. B. Buhr
G. A. Kronsbein
J. D. Coetzee
N. C. F. Steenekamp
T. C. W. Wessels
L. M. von Maltitz
J. Bergmann
C. Hibl
A. M. A. Schmidt-Dumont

APOLOGIES: Dr. A. M. Zschokke, Dr. P. A. Hughes, Dr. U Schreiber-Sigwart.

GUESTS: Dr. A Tarr
Dr. R. van der Westhuizen

NEW MEMBERS:

Drs. J. Joubert
D. de Lange
H. Schneider jnr.
P. A. Hughes
H. Ebedes

proposed by Dr. Steenekamp, seconded by Dr. Wessels and as such accepted by the meeting.

Dr. Halenke opens the meeting and welcomes everyone present, especially Dr. Tarr, new president of our Association, and the new members to the Branch.

The minutes of the meeting held in Windhoek on 25th October 1965 were read and approved.

The following *matter arising from the minutes* as discussed:

The question of language tests as raised by Dr. de la Rey in 1964 and 1965 was settled by the changes brought about by the latest circular of the Public Service Commission in this connection.

1. CHAIRMAN'S REPORT:

(i) Dr. Halenke reported on the advertisement in the "Sunday Times" on 13.2.66 for a Superintendent for Windhoek Abattoir in which a B.V.Sc degree was not mentioned as a possible qualification. Dr. Viljoen and Dr. Halenke talked to the Chief Health Inspector and he gave them the assurance that a B.V.Sc degree would be included under qualifications should this post be advertised once more.

(ii) He further reported on the committee meeting held on 31.8.66 in Dr. Buhr's office at which the points for the agenda, as they had been received from members, were discussed.

2. FINANCIAL REPORT

A credit balance of R98.55 was reported. The report was read and approved. Dr. Buhr proposed that Dr. Tarr be the guest of this Branch for the period of his stay in Windhoek; this was unanimously accepted by the meeting.

3. CORRESPONDENCE with mother body and registrar of veterinarians was read and approved.

4. ELECTION OF NEW OFFICE BEARERS

Dr. Coetzee proposed that committee be retained as it is, viz;.

Chairman: Dr. H. Halenke

Secretary: Dr. A. M. A. Schmidt-Dumont

Additional member: Dr. W. H. B. Buhr

No counter proposals were made. On behalf of the committee Dr. Halenke thanked the meeting for this vote of confidence.

5. ADDRESS BY SAVMA PRESIDENT

Dr. Tarr in his address expressed his sincere thanks for the invitation to attend this meeting and gave a short report on the activities of Council. He mentioned that in March 1967 it will be the *centenary of Dr. Theiler's birth*, which is a landmark in veterinary science in South Africa and that Faculty will organise a suitable commerative activity. Dr. Schneider suggested that we should try to have a commerative stamp issued.

Another matter arising out of Dr. Tarr's address was that of branch representation at Council meetings. He said that he was fully aware that expenses were the handicap, but he wanted to propose that we nominate a fully credited representative to attend Council meetings until this matter was finalised at the next Annual General Meeting. Dr. von Maltitz proposed Dr. Watt, Dr. Redelinghuijs seconded and the meeting approved.

Dr. Halenke opens the discussion on higher membership fees—which has been R1 ever since the Branch came into being in 1947. Dr. Viljoen feels that R1 is out of all proportion and he would like to suggest to raise it to R5. Dr. Buhr seconds and this is unanimously accepted by the meeting. Dr. Buhr also suggests that every member pays annually, even if he is not able to attend the annual meetings.

Dr. Viljoen takes up the matter of the investment of the funds of the Association raised earlier by Dr. Tarr. He feels that expert opinion is necessary to go into this question and then possibly have the funds re-invested in schemes with a relatively small income but a substantial growth factor. Dr. Tarr informs us that if the meeting feels thus, a resolution to this effect must be forwarded to Council and the matter will then have to be adopted by the next AGM.

6. REPORT: S.A.V.M.A. CONGRESS AT ONDERSTEPOORT

The following members: Drs. Watt, Buhr, Coetzee, Bergmann, Bilbrough, Schneider, de Lange, van Wyk and Joubert reported on the most interesting papers read at Congress.

(i) A lively discussiion ensued on the *pathology of "ramsiekte" and ram certification.* Dr. Buhr undertook to curculanse copies of the different staining methods received at Onderstepoort.

(ii) Drs. Bergmann, Buhr, Watt and van Wyk reported on *Leptospirosis* e.g. the fairly high incidence among piggeries in the Western Province; the difficulties encountered in diagnosis, symptomatology, treatment, carrier status, danger to man and vaccination.

(iii) Mention was made of the *gousiekte* symposium; *Dr. Thornton's Lecture* during the Public Health Group meeting; standards of tuberculin testing and the cost of *tuberculosis treatment* in cattle.

(iv) Dr. Watt reported on the outbreak of *scrapie in sheep*: its symptoms, pathology, diagnosis and that it will be listed as a scheduled disease.

7. FEES TO BE CHARGED FOR CLINICAL WORK BY STATE VETERINARIANS AND THE APPLICATION OF THE VETERINARY ACT TO S.W.A.

Dr. Redelinghuijs put his case: in his eyes there is a definite need for private practitioners in S.W.A. but that distances and the attitude of the farmers wanting every service for nothing, were the biggest problems for any private practitioner wanting to start working in S.W.A. To illustrate his point he mentioned that he travelled 7000 miles in one month, treated amongst others three stud-animals worth

together R10,000, but he felt that he can't charge the farmers for all the time and the distances spent on these cases.

His position is as follows: he only asks the minimum expenses, no professional fees, but expects from the farmers that they support his employer viz. Karroo Meat Exchange and four out of five farmers do this. In his opinion it is the farmers' duty to support his firm—according to the veterinary ethical code this is unethical, but what other chance has a private practitioner got in S.W.A.? He asks that state veterinarians not only charge mileage but also professional fees, then only can a private practitioner start making a living.

Dr. Tarr remarked that the basis on which Dr. Redelinghuijs works now, is incorrect and he suggested that it should be arranged on the basis of an annual guarantee by Karroo Meat Exchange.

Dr. Halenke points out that this matter has been raised every year at our meeting and we just seem to move in circles, getting nowhere. He feels that the principle of charging fees should be forced even if they have to be paid in to the consolidated Revenue fund. Dr. Tarr reports that in the R.S.A. they are busy with this same matter for a number of years already, but that they are thinking along the lines of appointing private practitioners as part-time state veterinarians on the basis of district surgeons in the medical profession.

Dr. Viljoen defined the duties of a state veterinarian as follows: control of scheduled diseases, examination of cases of gross mortality, control of erosion diseases and then, lastly, if there is time, to attend to sporadic clinical cases. In his opinion the idea of district veterinary surgeon is quite out of the question, because abovementioned duties of a state veterinarian will not leave much time for clinical cases. He is very much in favour of state veterinarians charging professional fees, but he feels that at this stage this matter must be taken up by the private practitioners themselves. The Department will support any suggestion from them along these lines. Drs. Halenke and Redelinghuijs both undertake to pursue this matter as suggested as soon as possible.

Dr. Redelinghuijs talked about the application of the Veterinary Act to S.W.A. again, but Dr. Halenke forestalled any further discussion by saying that a resolution from this meeting will serve no purpose as this is connected with the legal position of S.W.A. and as long as this is undecided, we can't do anything, but wait.

8. CONTROL OF PHD

Withdrawn by Dr. Schneider.

SUGGESTIONS FOR CHANGES OF ETHICAL CODE: Already discussed.

BETTER CONTROL OVER CLINICAL WORK DONE BY LAYMEN AT S.P.C.A.

Dr. Schneider mentions the case of the S.P.C.A. in Walvis Bay, where the chemist as chairman of S.P.C.A., treats dogs and cats i.e. he does the work of a veterinarian. He does not call himself a veterinarian, but he charges fees—and there is no law to prevent him doing this.

9. CONTROL OF VIBRIOSIS AND OTHER GENITAL DISEASES.

Dr. van Wyk reports on a few confirmed cases of vibriosis in the Grootfontein district including Uitkomst Experimental Farm. In his opinion it is prevalent in S.W.A. He asks the pertinent question: what should be our policy if vibriosis is confirmed on a farm? A lively discussion followed in which all the different methods of control of vibriosis were mentioned: keeping of accurate breeding records, artificial insemination, separate herds; treatment of individual animals; sexual rest of cows; farm management as regards condition and age of bulls used and number of cows per bull; control of internal and external parasites and vaccines available. Dr. Halenke summarises the discussion by saying that vibriosis is not a scheduled disease and that everyone of us must judge each case of vibriosis on its merits and advise the farmers accordingly.

10. A VETERINARIAN'S WORK IN GAME CONSERVATION.

Dr. Ebedes gave a very interesting talk on his work in the Etosha Game Park.

11. DURATION OF VETERINARY COURSE.

Dr. van Wyk pleads for the extension of the veterinary course. Dr. Tarr informs us that there is a committee appointed to examine this whole matter of veterinary education.

12. PROFESSIONAL PROVIDENT SOCIETY.

Dr. van Wyk talks about the Professional Provident Society, an insurance agency for professional people. He feels that it is an excellent scheme and he regrets that he hadn't heard about it while still being a Student. Dr. Tarr made a note to pass on this suggestion to Faculty.

13. MAKING OF SILAGE AND ITS NUTRITIVE VALUE.

Dr. van Wyk reports that silage making slowly becomes of more importance in his area and he just wanted to mention a very useful booklet: "Silage Maker's Handbook" published by Pan Britannica Industries, England, which gives new ideas on silage making.

14. MODERN FARMING METHODS IN S.W.A.

Dr. Halenke started off his talk by saying that he goes out from the principle that he "farms with grass and keeps sheep and cattle to harvest." With this underlying idea he divided his farming practice into four headings: management, breeding, feeding and disease control. Dr. Bergmann thanked him for this interesting and clear talk because he had demonstrated to us how everything we preach daily can be put into practice successfully.

15. GENERAL

(i) Dr. Buhr suggested a donation of R10.50 to the secretary—this was unanimously accepted by the meeting.

(ii) Dr. van der Westhuizen expressed his thanks for being able to attend this meeting.

(iii) Dr. Halenke proposed a vote of thanks to the S.W.A. Administration and the Department of Agriculture for the privilege of once more having been able to attend Congress and hold a meeting of veterinarians at Windhoek. This proposal was unanimously approved by the meeting.

(iv) As no further matters arose for discussion the meeting was adjourned.

(v) The day's proceedings were crowned by a most enjoyable "braaivleis" at the Continental Hotel.

FINAL VETERINARY CLASS 1967 FINALE VEEARTSENYKLAS

Front row: I. A. Scheepers, J. M. Hofmeyr, M. H. R. Fries, O. E. B. Swacina, J. P. Kitching, Miss/Mej. M. E. Wolf, P. D. Botha,
Voorry: Miss/Mej. H. M. Selfe, B. G. Gaisford, R. C. Clark, R. A. Kobus, H. Bark, B.C.D. Schubert.
Middle row: S. B. Buys, L. W. Marshall, A. D. B. Robey, I. Z. L. Berg, D. Schaap, W. v. N. le Clus, A. D. G. McGregor, C. B. Mc-
Middelry: Donald, H. R. du Preez, D. M. Burstein, B. A. P. Bagot-Smith, G. T. Hinze, A. G. Rose, A. E. Riley, L. D. J. Macaulay.
Back row: J. S. J. Kruger, G. V. S. Turner, J. Friedman, T. S. Kellerman, K-A. J. von Maltzahn, O. Marais, J. H. Grobler, H. J.
Agterry: Lucks, J. W. S. Liebenberg, R. Cooper, M. R. Irwin, J. D. Rens, A. H. Reitz, G. Bouloutis, R. J. Minnaar.

FAKULTEIT VEEARTSENYKUNDE

MEDALJES EN PRYSE AAN GRADUANDI TOEGEKEN NOVEMBER 1967

1. THEILER-MEDALJE.
   L. D. J. Macaulay.

2. KLINIESE MEDALJE.
   Mej. H. M. Selfe.

IMPERIAL CHEMICALS-PRYS.

1. Geneeskunde en Infeksiesiektes.
   J. W. S. Liebenberg.

2. Chirurgie en Genesiologie.
   P. D. Botha.

4. Agricura-Prys.
   Mej. H. M. Selfe.

5. LILY LABORATORIES-PRYS.
   S. B. Buys.

6. PFIZER-PRYS.
   J. W. S. Liebenberg.

7. MAY BAKER- KLINIESE PRYS.
   R. A. Kobus.

8. S.A.V.M.V.-REPRODUKSIEGROEP-PRYS.
   J. W. S. Liebenberg.

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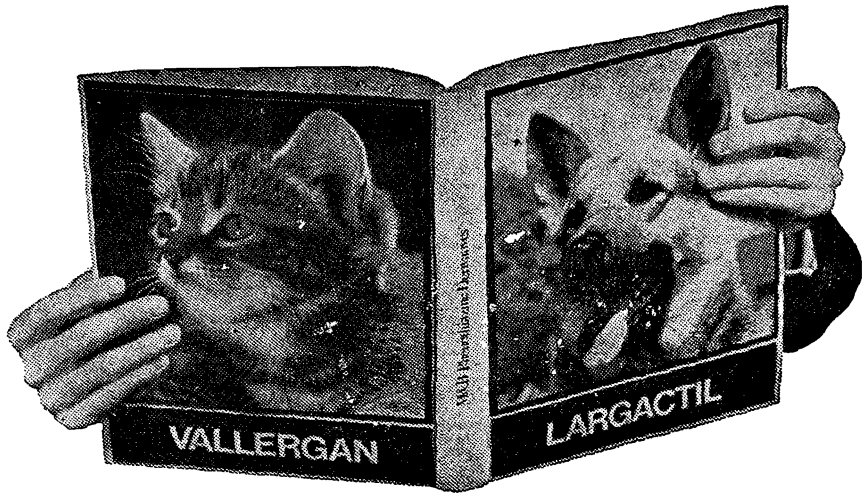

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MAIN SUBJECT INDEX
(CROSS-INDEXED)

INHOUDSOPGAWE VOLGENS VAKINDELING
(MET KRUISVERWYSINGS)

The items listed below each subject heading refer to main key-words in the alphabetical index.
Die terme onder elke vakhoof verwys na hoofsleutelwoorde in die alfabetiese inhoudsopgawe.

ALPHABETICAL INDEX

ALFABETIESE INHOUDSOPGAWE

An asterisk preceding the key-word(s) indicates that the full title is given, otherwise titles are abbreviated.
'n Sterretjie voor die sleutelwoord(e) dui 'n vollengte titel aan, andersins is die opskrifte afgekort.

Bold figures — senior or sole auther.
Swart syfers— senior of enigste outeur.