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CONTENTS / INHOUD

CORRIGENDA

1. The title of the article 'Fluctuations in Pituitary FSH and LH in the Normally Cycling Angora Goat' by P.S. Pretorius in the September issue, p.279 of this Volume, (44) should read: "Fluctuations in Pituitary FSH and LH in the Normally Cycling AND ANOESTROUS Angora Goat". The word DI-OESTROUS should be replaced by ANOESTROUS throughout the text and figure. A corrected version will be reprinted in Vol. 45, No. 3 (September issue).

2. The photograph in the figure on page 48 of this Volume (44) (The Relationship between Protein Polymorphism and Mastitis in Friesland Cows) was reversed and must be replaced by the accompanying one.

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EDITORIAL

VETERINARY EDUCATION IN SOUTH AFRICA

After analysis of the implications of the recent organisational change affecting the Faculty of Veterinary Science *, the present over-all picture of veterinary education in South Africa deserves closer scrutiny. In the light of more than half a century's experience of training veterinarians in this country, certain pronouncements may be made.

We are fortunate indeed to have had outstanding people and scientists to lay a firm foundation for education in its initial years in South Africa. It was also a happy coincidence that the first members of the teaching staff had a sound balance of backgrounds emanating from the various European mother countries. The European background, coupled with the typical ingenuity, resourcefulness, level-headed insight and the ability to adapt overseas experience to South African circumstances, created a synthesis of potential strength. This tradition critically to seek the best that overseas knowledge had to offer and to apply it meaningfully has been upheld successfully.

During subsequent development the Faculty had to strengthen itself from its own progeny. The dangers of intellectual incest were fully appreciated. These were alleviated by maintaining an open mind, utilizing opportunities for overseas experience whenever possible, maintaining close contact with medical confreres and keeping an open eye on world developments in the various specialized disciplines. One proof that this policy has succeeded may be offered; teachers of this Faculty have been invited as guest teachers and speakers to other countries. Chairs offered in two instances in the Faculty of Medicine at the University of Pretoria, and in one at the University of Ohio, have been accepted by members of our Faculty.

Another tradition, maintained with pride, is the meticulous care given to sound, scientifically founded, basic training. All efforts to water down the course have been repelled vigorously. A spirit of critical self-analysis

*See the June issue of this Journal (Vol. 44 No. 2).

REDAKSIONEEL

VEEARTSENYKUNDIGE OPLEIDING IN SUID-AFRIKA

Na ontleding van die implikasies van die onlangse organisatoriese verandering wat die Fakulteit Veeartsenykunde ondergaan het *, behoort die huidige geheelbeeld van veeartsenykundige opleiding in Suid-Afrika in oënskou geneem te word. In die lig van meer as 'n halwe eeu se ervaring van opleiding van diere-artse hier te lande kan 'n paar stellings gelug word.

Ons was voorwaar gelukkig om voortreflike wetenskaplikes en mense te gehad het om 'n stewige beslag aan die opleiding in sy beginjare in Suid-Afrika te gee. Ook was dit 'n gelukkige toedrag van sake dat die eerste lede van die doserende personeel 'n goeie balans van agtergrond vanuit die onderskeie Europese stamlande verteenwoordig het. Die Europese agtergrond gekoppel aan die tipiese vernuf, vindingrykheid, nugterheid van insig en vermoë om oorsese ervaring by Suid-Afrikaanse omstandighede aan te pas, het 'n sintese geskep waaruit besondere krag geput is. Hierdie tradisie om krities die beste uit te soek wat buitelandse kennis kon aanbied en dit sinvol aan en toe te pas is met vrug volgehou.

Namate die Fakulteit homself al meer uit sy eie nasate moes voed, is die gevaar van intellektuele inteelt deeglik besef. Dit is bekamp deur 'n onbekrompe gees te handhaaf, soveel moontlik geleenthede tot oorsese ervaring te benut, noue kontakte met mediese geesgenote in Suid-Afrika te handhaaf, en deurgaans 'n ope oog te hou op wêreldwye verwikkelings op die onderskeie gespesialiseerde vakgebiede. As bewyspunte dat dié beleid geslaagd was, kan aangehaal word dat dosente van die Fakulteit as gasdosente en -sprekers in die buiteland opgetree het, in twee gevalle aangebode professorate in die Fakulteit Geneeskunde van die Universiteit van Pretoria en een aan die Universiteit van Columbus, Ohio, aanvaar is.

'n Ander tradisie wat steeds met trots gehandhaaf is, is die deeglike sorg wat aan

*Sien die Junie-uitgawe van hierdie blad (Bd. 44 No. 2)

coupled with unflagging efforts to improve the course and adapt it to new needs, is another characteristic of the Faculty's approach to its task.

All this, however, does not justify a sense of absolute satisfaction. One difficulty is to be found in the fact that no reliable, comprehensive and objective standard of evaluation exists. Logically one could argue that the level of a faculty is reflected by the level of its graduates. But how does one assesss the true value of a professional person? Some examples may be cited. A young graduate was rated by an experienced practitioner of high repute as the poorest he had ever encountered. This particular graduate is today one of the foremost research workers in a country with probably the stiffest competition in the field of science in the whole world. A lecturer, not regarded as fit for promotion to a senior post, after a few years occupies a chair in one of the top universities of America and receives an award as 'outstanding educator of the year'. Where today more attention is being given to increased effectiveness of tertiary education, it is possibly a task of high priority which the bodies for university research recently instituted at our various universities, as well as the Human Sciences Research Council, could consider; the setting up of standards for evaluating the effectiveness of faculties. It would be a gigantic task and, until such standards have been created, one must perforce depend on as global a totality of objective norms and trust that the final outcome might prove to be a judicious guess.

One norm that may prove reasonably reliable is that which takes cognizance of the measure of success a graduate from a particular faculty attains when placed in competitive surrounding with graduates from other, similar faculties in leading countries of the world. According to this standard, the Faculty of Veterinary Science has reasonable grounds for satisfaction. If the percentage 'drop-outs' is used as indication, one finds that of all students who have entered the professional part of the course, i.e., the second year of the five year course, from the inception of the Faculty up to and including the year 1968, 9 per cent have failed to complete their studies. Fifty-eight per cent have completed the course within the minimum time laid down, 15 per cent have required an additional semester, 18 per cent have needed one year or more additionally.

Amongst the 'drop-outs' are persons who

basiese, wetenskaplik gefundeerde opleiding gegee word. Alle pogings, van watter oord ookal, om die kursus af te water, is kragtig teengestaan. 'n Gees van kritiese self-analise met volgehoue pogings om die kursus te verbeter en by nuwe eise aan te pas, is 'n verdere kenmerk van die Fakulteit se benadering tot sy taak.

Dit alles bied egter geen regverdiging vir algehele tevredenheid nie. Die knelpunt lê daarin, dat daar geen betroubare, omvattende, objektiewe waardebepalingsnorme bestaan nie. Logies kan 'n mens redeneer dat die peil van 'n fakulteit geskat kan word volgens die peil van sy graduandi. Maar hoe bepaal 'n mens die werklike waarde van 'n professionele persoon? 'n Paar voorbeelde mag hier aangehaal word. 'n Jong graduandus is deur 'n ervare en gesiene praktisyn bestempel as die swakste wat hy ooit in diens geneem het. Dieselfde graduandus is vandag een van die voorste navorsers in 'n land met seker die moordendste kompetisie op wetenskaplike gebied ter wêreld. 'n Dosent wat nie geskik geag is om tot senior lektor bevorder te word nie, is na 'n paar jaar bekleër van 'n leerstoel in een van die voorste universiteite van Amerika, en kry 'n toekenning as die land se „voortreflikste opvoeder van die jaar". Waar daar vandag begin word om groter aandag aan doeltreffender tersiëre opleiding te gee, is dit miskien een aangewese taak met hoë voorrang waaroor die onlangs gestigte institute vir universiteitsnavorsing aan ons onderskeie universiteite, asook die Raad vir Geesteswetenskaplike Navorsing, kan besin: die daarstel van waardebepalende norme vir doeltreffendheid van fakulteite. Dit sal 'n reuse-taak wees en tot dan moet 'n mens maar op so 'n groot totaliteit van objektiewe en subjektiewe norme staatmaak, en vertrou dat die finale uitslag 'n gelukkige kolskoot sal wees. Een norm wat as redelik insiggewend kan geld, is die volgende: hoe vaar die graduandi van 'n fakulteit as hulle in fel wedywerende milieu met graduandi van Fakulteite in toonaangewende lande ter wêreld geplaas word? Volgens hierdie norm het die Fakulteit Veeartsenykunde redelike gronde tot tevredenheid. Gebruik 'n mens die uitsakpersentasie as aanduiding, dan vind 'n mens dat van alle studente wat sedert die ontstaan van die Fakulteit tot die professionele deel van die kursus, dit is die tweede studiejaar van die vyfjarige kursus, tot en met 1968 toegelaat is, daar 9 persent uitgesak het. Agt-en-vyftig persent het in die minimumtydperk

have made a change out of their own free choice and who have subsequently followed successful careers in other directions — one of the leading medical researchers is included here. Measured against general results of training professional people, the achievement of this Faculty is not too poor. But, once again, under no circumstances may there be a resting on laurels. In the final instance, laurels are destined to enshrine the vertex, not the coccyx.

The problems facing the Faculty of Veterinary Science are universal ones, but have a strong local colour in addition. Firstly there is the problem of conveying knowledge, which is increasing exponentially, to students within the same time limit as before. The facile argument can be adopted that old knowledge is replaced by new and that advanced knowledge must be relegated to post-graduate teaching. This argument is totally over-simplified. In biology it is more often than not the most advanced knowledge that forms the very basis of our understanding. Twenty years ago the Watson-Crick model was an esoteric novelty: today it forms part and parcel of secondary school teaching. Those parts of older knowledge that become obsolete are replaced by newer knowledge of exponentially increasing compass. There are only three solutions and all three are applicable to professional training: practically acceptable extension of a course†, internal rationalization, and the creation of a docent body that is capable of reducing enormous masses of factual data to relatively simple, manoeuvrable proportions and of crystallizing essentials without prostituting the truth. Not only must university authorities devise methods of drawing the most outstanding teachers, but working conditions must be such that the teachers can live up to their ideals. The limited man-power, and hence the less competitive supply, as well as the limited financial sources, so typical of the South African scene, are not conducive to a solution. On the one hand appreciative mention is made of the efforts of the University to obtain funds for the Faculty, on the other hand sympathy is expressed to those who have to apportion funds. Lack of information concerning the determination of priorities in the latter process, generates the

†Such an extension, already proposed by the Faculty, had to be postponed owing to uncertainty of fund provision.

die kursus voltooi, 15 persent het 'n addisionele semester nodig gehad en 18 persent het een bykomstige studiejaar of meer nodig gehad. Onder die uitsakkelinge is daar 'n hele paar wat om persoonlike voorkeurredes van kursus verander het en 'n baie suksesvolle loopbaan gevolg het — dit sluit een van die wêreld se voorste mediese navorsers in. Gemeet aan algemene professionele opleidingsresultate is dit nie swak nie. Maar weereens, daar mag onder geen omstandighede op die louere gerus word nie. Per slot van sake is louere vir die hoof en nie vir die sitvlak bestem nie.

Die knelpunte wat die Fakulteit Veeartsenykunde in die gesig staar is universeel van aard, met 'n sterk plaaslike kleur daarby. Daar is eerstens die probleem om eksponensieel toenemende kennis binne dieselfde tydsbestek as voorheen aan studente oor te dra. So gemaklik kan breedweg ge-argumenteer word dat die nuwe kennis die ou kennis vervang en dat gevorderde kennis op nagraadse vlak gedoseer moet word. Hierdie stellings berus op aanname van verregaande oorvereenvoudigings. In die biologie is die mees gevorderde kennis juis dié kennis wat die werklike basis van ons begrip vorm. Twintig jaar gelede was die Watson-Crick-model 'n esoteriese nuutjie: vandag vorm dit deel van hoërskoolonderrig. Die dele van ou kennis wat verval, word vervang deur kennis van eksponensieel toenemende omvang. Daar is slegs drie oplossings, en al drie is van toepassing in professionele opleiding: prakties aanneembare kursusverlenging†, interne rasionalisasie, en die skep van 'n dosente-korps wat in staat is om 'n enorme vrag feitelike gegewens tot 'n betreklik eenvoudige en hanteerbare omvang te verminder en die essensiële uit te kristalliseer sonder om die werklikheid geweld aan te doen. Nie alleen moet die universiteitsowerhede metodes ontwerp om slegs die puikste leerkragte te trek nie, maar werksomstandighede moet sodanig wees dat hulle hulself ten volle kan uitlewe. Die beperkte mannekrag met gevolglik minder meedingende aanbod en beperkte finansiële bronne, kenmerkend van die Suid-Afrikaanse toneel, dra nie juis tot 'n oplosing by nie. Enersyds word met waardering gewag gemaak van die universiteitsowerhede se

†Sodanige verlenging, reeds deur die Fakulteit aanbeveel, moes uitgestel word weens onsekerheid van fondsvoorsiening.

undermining suspicion that the Faculty is a victim of a parsimonious financial policy.

Secondly, there is the problem of adequate development of student knowledge. Concerning the transmission of information, great strides have been made. Numerous aids have been developed to assist the teacher. But they cost money and their adequate usage demands much time and prior effort on behalf of the teacher. The crux of the problem is to be found in the fact that upon appointment no teaching experience in the broadest sense is expected from university lecturers. Reliance is placed entirely on the sink or swim method. Fortunately there are indications of change.

The traditional method of university education by means of formal lectures could come in well for criticism. An extremely important aspect is one which hitherto has been neglected sadly. Attention is only now being focussed on the transfer of knowledge from teacher to student. This is laudable in every respect, but the real crux of this matter lies in the *process of mental assimilation* by the student and the *testing* whether he has done so properly. If the Faculty's time-table were to be scrutinized more closely, a distressing fact would emerge: it is based on the idiotic fallacy that a fact, once mentioned to a student, will be remembered by him. More than 99 per cent of the time is spent on conveying information to the student, less — much less — than one per cent to discussion and testing. The latter should occupy at least 50 per cent of teaching time. If the question is posed why this should be so, the unavoidable answer is: no time! And note, it is in applied biology of all disciplines that *true* knowledge, insight and understanding develop but slowly, no matter how gifted the student. He requires constant practice, not only in assimilating and digesting intellectual concepts, but particularly also in practical aspects, such as application of knowledge, observation, identification, diagnosis and handling of animals and instruments. It is the practical side, especially, that requires close student-teacher contact and hence a narrow student-teacher ratio.

A third problem is the increasing number of potential students that have to be rejected on account of sheer lack of physical accommodation. The numbers have increased rapidly over the last few years. At the beginning of 1973, 111 students, who in every respect had qualified for entry to the second year of

pogings om fondse ten behoewe van die Fakulteit te bekom, andersyds word daar gesimpatiseer met diegene wat die lakens moet uitdeel. Gebrek aan inligting oor hoe daardie uitdeling geskied, laat die ondermynende agterdog ontstaan dat die Fakulteit 'n slagoffer is van 'n berooide finansbeleid.

Tweedens is daar die probleem van doeltreffende kennisontwikkeling by die student. Op die gebied van kennisoordrag word daar wel groot vorderings gemaak. Allerlei hulpmiddels word vandag ontwikkel om die dosent by te staan. Maar hulle kos geld en hul behoorlike benutting verg geweldige tyd en inspanning vooraf deur die dosent. Die kern van die probleem lê in die feit dat van universiteitsdosente by aanstelling geen ervaring in onderwys in sy breedste sin verwag word nie. Die sink-of-swem-metode word maar deurgaans op vertrou. Gelukkig is daar aanduidings van kentering.

Die tradisionele wyse van universiteitsopleiding deur middel van formele lesings kan gerus deeglik onder skoot geneem word. 'n Uiters belangrike faset is een waarop voorasnog bitter min klem gelê is. Ons begin nou aandag op die oordraging van kennis van dosent aan student toespits; dit is allersins lofwaardig, maar die eintlike spilpunt is die *proses van geestelike verwerking* deur die student en die *toetsing* of hy dit wel behoorlik verwerk het. Beskou 'n mens die Fakulteit se roosters van naderby, dan ontdek 'n mens 'n ontstellende feit. Hulle is gebaseer op die verspotte aanname dat 'n feit, eenmaal aan 'n student genoem, hom blywend sal bybly: meer as 99 persent van die tyd word aan kennisoordraging gewy en minder — baie minder — as een persent aan bespreking en toetsing. Laasgenoemde behoort ten minste 50 persent van die tyd in beslag te neem. Vra 'n mens waarom dit so is, is die antwoord die onvermydelike een: geen tyd! En let wel: dit is in die toegepaste biologie van alle gebiede dat *ware* kennis, insig en begrip maar stadig by die student ontwikkel, al is hy ook hoe begaafd. Hy het gedurig oefening nodig, nie net in intellektuele begripsverwerking nie, maar veral ook in praktiese fasette, soos toepassing van kennis, waarneming, identifikasie, diagnose-stellings en in diere- en instrumentarium-hantering. Veral laasgenoemde prosesse verg 'n noue dosent-student-kontak en dus 'n noue dosent-student-getalsverhouding.

'n Derde ernstige knelpunt is die toene-

study, had to be refused such entry, as against the 46 admitted. Selection of students is done mathematically on grounds of academic achievement only and this year the minimum selection mark was 67%, on a scale on which 50% is a pass mark, 55—64% is regarded as average, 65—74% as above average and 75% or more as a pass with honours. It must be mentioned that a student whose average mark for the required first year science subjects was too low to ensure his entry to the professional part of the course can obtain extra credits by successfully completing other university courses. He obtains 8% for every additional university year successfully completed. * The result is that more and more graduates in other directions (mainly Science and Agriculture) are admitted. Experience has shown that an alarming number of such graduates does poorly in professional training, considering expectations in terms of their pre-professional degree. At one stage it appeared as if graduates who had worked for some time after obtaining the first degree constituted the material of choice, but this norm has also proven to be fallible. This fact is mentioned in view of the tendency in some countries to admit graduates only to the professional course. Basically the issue devolves upon the question: how does one gauge aptitude and motivation objectively and reliably?

In passing, brief reference is made to the shifting accent in education to equip the veterinarian to play a bigger rôle in animal production, without, however, loss of clinical acumen.

The problem of inadequate teaching facilities must be seen in terms of the country's requirements. In 1967 a Committee of Faculty found that 90 students had to be admitted annually to cope with the country's requirements by the year 2,000. 'Tis true that there is a subtle but very important practical difference between the number *required* and the number a country is willing to *bear economically*. This fact had been borne in mind. This figure was accepted by the authority of the day and planning was set in operation immediately. But, under strong public pressure, the State had to impose financial stringencies in all directions, then considerations concerning the excorporation of the Faculty of Veterinary Science from the Department of Agricultural-Technical Services called a halt to

*As from the beginning of 1974, this has been reduced to 4%.

mende aantal potensiële studente wat weggewys moet word weens gebrek aan fisiese ruimte. Die getalle het ook die laaste paar jaar vinnig gestyg. Aanvang 1973 is 111 studente, wat in alle opsigte vir toelating tot die tweede studiejaar gekwalifiseer het, weggewys, teenoor die 46 wat toegelaat is. Keuring van studente geskied bloot matematies op grond van akademiese prestasie, en vanjaar was die minimum keursyfer 67%; dit is op 'n skaal waar 50% as slaagsyfer geld, 55—64% as gemiddeld, 65—74% as bogemiddeld en 75% of meer as slaag met lof. Hier dien bygevoeg te word dat 'n student, wie se gemiddelde puntetal vir die vereiste eerstejaarswetenskapvakke te laag was om hom toegang tot die professionele deel van die kursus te verleen, ekstra krediete kan verwerf deur ander universiteitskursusse met sukses te deurloop: hy kry dan 8% by vir elke volle universiteitstudiejaar geslaag*. Die verskynsel doen hom nou voor dat al hoe meer graduandi in ander rigtings (hoofsaaklik Wetenskap en Landbou) toegelaat word. Die ervaring het egter geleer dat 'n onstellende persentasie van hierdie graduandi swak presteer in hul professionele opleiding, veral as na verwagtings uit hoofde van hul vorige graad gekyk word. Op een stadium wou dit voorkom asof graduandi, wat voorheen eers gewerk het na behaling van die eerste graad, die regte keuse is. Maar nadere beskouing het ook hierdie maatstaf as onbetroubaar bewys. Hierdie feite word aangehaal na aanleding van die neiging in sommige lande om slegs gegradueerdes tot die professionele kursus toe te laat. Basies kom dit daarop neer, hoe bepaal 'n mens aanleg en motivering op 'n betroubare, objektiewe wyse? Dit is die probleem waarmee 'n Fakulteitskomitee nou worstel.

Korktliks word hier ook verwys na die nodige klemverskuiwing in opleiding om diere-artse 'n groter rol in veeproduksie te laat speel sonder om kliniese bedrewenheid in te boet.

Die knelpunt van onvoldoende opleidingsfasilitite moet gesien word in terme van landsvereistes. In 1967 het 'n Fakulteitskomitee bevind dat 90 studente per jaar vanaf 1972 ingeneem sou moes word om teen die jaar 2000 aan alle behoeftes te voorsien. Weliswaar is daar 'n subtiele maar prakties uiters belangrike verskil tussen die getal wat *nodig* is en die getal wat 'n land *bereid is om*

*Vanaf aanvang 1974 is dit verminder na 4%

all action, and now the University sits with its hands tied waiting for the report of the commission investigating the state subsidy formula for universities, a report that had been deferred for the umpteenth time.

For the sake of completeness it must be mentioned that with the erection of the present complex of buildings in the early 'fifties for the basic and clinical Faculty departments, it was the generally held opinion that admission of 30 students per year would be more than adequate. Ten years later the existing space had to be reorganized to capacity to take 45 students per year. Everyone was convinced that this would be adequate for the foreseeable future. Is a decade a foreseeable future?

Finally there are the unavoidable financial problems. The ubiquitous and all-embracing spiral of inflation has an added exponential factor when it comes to science and science teaching. With increased refinements in technique the cost of instrumentation increases asymptotically. Some thirty years ago a good light miscroscope (at R150) was the standard instrument. Today, that instrument (at R450) is still required, but without an electron microscope (at R50 000 with accessories) no Department of Histology, Pathology or Virology is complete. To study the seemingly simple phenomenon of synaptic transmission of nerve impulses requires apparatus to the tune of R100 000. Handling of sophisticated instruments requires expert operators, who must receive commensurate salaries. Biological technology has become as self-generating as biological organisms!

The S.A.V.A. has done its full share in concerning itself with veterinary education. According to a majority decision, the Association was in favour of the erection of a second faculty instead of expansion of the present one. Representations to this effect have been laid repeatedly before the authorities concerned. The Veterinary Foundation was created with the primary purpose to make financial contributions towards such a faculty. The most recent deputation interviewed the Minister of Agriculture and the Minister of National Education on May 3rd of this year. The answer to representations was a polite but firm 'No'. At its subsequent meeting, the Council of the S.A.V.A. decided that the matter of veterinary education could best be served by formation of a standing committee, consisting of persons with

a) thorough experience in the present

ekonomies te dra. Maar hierdie punt was wel terdeë in ag geneem. Dié syfer is deur die owerheid van die dag aanvaar, en daar is onmiddellik begin met beplanning. Maar onder sterk druk van openbare mening moes die Staat van alle kante besnoei, daarna het oorwegings met betrekking tot uitlywing van die Fakulteit Veeartsenykunde uit die Departement Landbou-tegniese Dienste enige onmiddellike en daadwerklike optrede gefnuik, en nou sit die Universiteit finansieel met afgekapte hande en wag op die vir die soveelste keer uitgestelde verslag van die kommissie insake hersiening van die staatsubsidie formule vir universiteite.

Terwille van volledigheid kan hier kortliks vermeld word dat met oprigting van die huidige geboue-kompleks vir die basiese en kliniese Fakulteitsdepartemente in die vroeë vyftigerjare, daar allerweë gemeen was dat 'n inname-getal van 30 per jaar ruim voldoende sou wees. Tien jaar later moes die bestaande ruimte tot maksimum kapasiteit herorganiseer word om 45 studente per jaar in te neem. Almal was toe oortuig dat dit vir die afsienbare toekoms voldoende sou wees. Is 'n dekade 'n afsienbare toekoms?

Ten slotte is daar die onvermydelike finansiële probleem. Die allerweë en alom stygende inflasiespiraal kry in die wetenskap en wetenskaplike opleiding 'n eksponensiële faktor by. Met toenemende verfyning van tegnieke neem die koste van instrumentarium asimptoties toe. 'n Dertig jaar gelede was 'n goeie ligmikroskoop (teen R150) die standaard instrument. Vandag is daardie instrument (teen R450) nog nodig, maar sonder 'n elektrone-mikroskoop (teen R50 000 met bybehore) is geen histologie-, patologie- of virologie-afdeling volwaardig nie. Om die skynbaar eenvoudige kwessie van sinaptiese oordraging van senuprikkels na te vors, vereis apparatuur van R100 000. Instrumenthantering vereis daarby al hoe meer deskundige bedieners, wat ooreenstemmende salarisse moet kry. Die biologiese tegnologie het so selfgenererend soos biologiese wesens geword!

Die SAVV het ruim sy deel bygedra om hom te beywer vir behoorlike veterinêre opleiding. Volgens meerderheidsbesluit was die Vereniging ten gunste van die oprig van 'n tweede fakulteit in plaas van uitbreiding van die huidige een, en herhaalde vertoë is tot die betrokke instansies gerig. Die Veterinêre Stigting is in die lewe geroep met primêre

Faculty, but now no longer attached thereto;

b) thorough experience in veterinary research in general and university research in particular;

c) thorough experience in private practice;

d) thorough experience in business management.

The elected Committee, with powers of co-optation, is constituted by the following persons:—

Prof. J. M. M. Brown (convenor),
Dr B. H. Pappin,
Dr D. K. Shone.†

The Committee will be responsible for:—

1) Supporting in every way possible the educational efforts of faculties for the training of veterinary and paraveterinary personnel in the Republic of South Africa.
2) Evaluating the facilities available for veterinary and paraveterinary training at such faculties and to endeavour in every way possible to assist in providing optimum facilities at such institutions.
3) Investigating the country's present and future requirements in terms of veterinarians and paraveterinary personnel.
4) Maintaining a constant vigil over the educational standards of new veterinary and paraveterinary graduates and diploma students and to make suggestions for consideration by the bodies concerned when any deficiencies in training become apparent.
5) Liaising and consulting, where necessary, with the Veterinary Board on matters relevant to any veterinary and paraveterinary educational problems.

Appointment of this Committee does not imply that members of the Association may now relax and waive all thoughts concerning veterinary education. However competent its members may be, the Committee cannot be expected to discharge its duties in an isolated vacuum. More than moral support is required. On the other hand the Committee may not be handicapped in carrying out its task by wild statements and complaints: it is not a grievances committee. Its target is clear and positive: similarly, positive contributions are expected. Now is the time for fearless,

†This committee has been enlarged by the inclusion of Profs W. L. Jenkins, A. L. Littlejohn and Dr L. van Wyk to concern itself with continued education as well.

doel om finansiële bydrae tot so 'n fakulteit te kan maak. Die jongste afvaardiging van die Raad van die SAVV is op 3 Mei vanjaar deur die Minister van Landbou en die Minister van Nasionale Opvoeding te woord gestaan. Die antwoord op vertoë was 'n beleefde, dog besliste en ferme „Nee". Op die daaropvolgende Raadsvergadering het die Raad besluit dat die saak van veeartsenykundige opleiding die beste gedien kan word deur 'n vaste komitee in die lewe te roep, bestaande uit persone met:

a) deeglike ervaring in die bestaande Fakulteit, maar nou nie meer daaraan verbonde nie;

b) deeglike ervaring in veeartsenykundige navorsing in die besonder en met universiteitsnavorsing in die algemeen;

c) deeglike ervaring in die private praktyk;

d) deeglike ervaring in bestuurspraktyk.

Die gekose lede van die komitee, wat die reg tot ko-optering het, is soos volg:

Prof J. M. M. Brown (saamroeper),
Dr B. H. Pappin,
Dr D. K. Shone.†

Die opdrag aan die komitee lui:—

1) Om op elke wyse moontlik die opvoedkundige pogings van fakulteite vir die opleiding vir veterinêre en paraveterinêre personeel in die Republiek van Suid-Afrika te ondersteum en te bevorder.
2) Om die beskikbare fasiliteite vir veterinêre en paraveterinêre opleiding aan die betrokke inrigtings te evalueer en op elke wyse moontlik die daarstelling van optimum-fasiliteite aan sodanige inrigtings te bewerkstellig.
3) Om die land se huidige en toekomstige behoeftes aan veterinêre personeel te bepaal.
4) Om gedurige toesig te hou oor die opleidingspeil van veterinêre en paraveterinêre graduandi en gediplomeerdes, en om voorstelle te maak ter oorweging deur die betrokke instansies sodra enige tekortkominge in opleiding blyk.
5) Om raadplegend met die Veeartsraad te skakel oor enige saak rakende veterinêre en paraveterinêre opleidingsprobleme.

Met benoeming van hierdie komitee beteken dit nie dat lede van die Vereniging

†Dié Komittee is uitgebrei deur benoeming van proff. W. L. Jenkins, A. Littlejohn en dr L. van Wyk om ook na voortgesette onderwys om te sien.

unhampered thinking on a grandiose scale. Much gas has already accumulated on this subject. Some strong sparks could lead to salutary explosions.

Concerning education in veterinary science for members of the various Bantu nations, who possess 38 per cent of the total cattle population in South Africa, more, it is hoped, may be said at a later stage. At present it can be stated with some measure of satisfaction that planning is already in an advanced stage. Because of clearly envisaged logistic problems, only one college will be established initially. It will have to be interethnic and hence be erected outside the existing ethnic territories at an acceptable interethnic site. Such a site shall be so situated that geographical considerations will in no way hamper the staff of the Veterinary Research Institute nor of the Faculty of Veterinary Science to give all the assistance initially required. It shall also give access to stock thus far unexploited by veterinary services. The training methodology must be specifically adapted to the people to be served. The eventual level to be attained may in no way be inferior and persons so qualified must be fully acceptable for registration as veternarians by the Veterinary Board.

Initially the training of ten students per year is envisaged. Further development will depend on the demand for black veterinarians and the supply of suitable student material.

It is also clear that the matter cannot be left there. Now already, a start should be made for the creation of economically rewarding spheres of work, in which the graduates can be absorbed fruitfully. Having arrived at this concept, one finds oneself at once in the heart of the problematics of Africa.

To forestall any misconceptions at the outset, it must be pointed out that the whole matter is being dealt with by the Departments of Bantu Administration and Development and Bantu Education. According to Government policy internecine competition for funds, facilities and man-power between the existing Faculty or future faculties for whites on the one hand and a faculty or faculties for blacks on the other is out of the question. Advancement of the one will in no way detract from the other.

Objective scrutiny of the logistics of veterinary education from a broad point of

nou rustig die kwessie van veeartsenykundige opleiding uit hul gedagtes ter syde kan stoot nie. Hoe bekwaam sy lede ookal mag wees, dit kan nie verwag word dat die komitee in 'n afgeslote lugleegte sy taak na behore sal kan verrig nie. Meer as net morele ondersteuning is nodig. Maar die komitee mag ook nie in sy taak gerem word deur wilde bewerings en klagtes nie: dis nie 'n griewekomitee nie. Sy taakstelling is duidelik positief, insgelyks word positiewe bydraes van lede verwag. Nou is die tyd dat daar vreesloos en onbenepe wyd en ver gedink moet word. Daar is al baie gas oor hierdie onderwerp aangesamel. 'n Paar sterk ontbrandingsvonke behoort tot heilsame ontploffings te lei.

Wat betref opleiding in die veeartsenykunde van lede van die onderskeie Bantoevolke, wat 38 persent van die totale veestapel in Suid-Afrika besit, sal hopelik later meer gesê kan word. Op die oomblik kan met 'n mate van voldoening gekonstateer word dat beplanning reeds in 'n gevorderde stadium is. Omrede duidelik te voorsiene logistiese probleme, sal ten aanvang slegs een opleidingskollege gestig word. Dit sal dus interetnies wees, en daarom ook buite die bestaande etniese gebiede op 'n aanneemlike inter-etniese terrein opgerig word. Sodanige terrein sal so geleë wees dat geografiese oorwegings nie die personeel van die Instituut vir Veeartsenykundige Navorsing en die Fakulteit Veeartsenykunde enigsins sal kortwiek om volle hulp in die aanvangsjare te verleen nie. Ook sal dit toegang verleen aan 'n tot dusver veeartsenykundig onbearbeide veestapel. Die opleidingsmetodiek sal spesifiek aangepas moet wees by die volkere wat bedien moet word, maar die uiteindelike peil behaal sal in geen opsig minderwaardig wees nie en sal vir die Veeartsraad ten volle aanvaarbaar moet wees vir registrasie as veearts.

Aanvanklik word opleiding van tien studente per jaar beoog. Verdere groei sal afhang van die aanvraag vir opgeleide swart veeartse en die aanbod van geskikte studentemateriaal.

Dis ook duidelik dat die saak nie net daar gelaat kan word nie. Daar sal nou alreeds 'n begin gemaak moet word vir die skepping van 'n ekonomies lonende arbeidsveld, waar die graduandi met vrug kan werk. Daarmee staan 'n mens ineens in die hart van die groot Afrikaproblematiek.

Ten einde enige wanopvattings by voorbaat uit die weg te ruim, dien daarop gewys

view leads to the following solution as the most economical, practical and academically most acceptable. Build a new faculty on the site of the experimental farm of the University of Pretoria and hand the existing complex to Bantu Education. Casting forth this bone of contention will suffice for the present.

te word dat die hele aangeleentheid deur die Departemente van Bantoe-administrasie en Ontwikkeling en van Bantoe-onderwys behartig word. Ooreenkomstig Regeringsbeleid kan daar dus hoegenaamd geen sprake wees van onderlinge kompetisie met bestaande of toekomstige fakulteite vir blankes om fondse, geriewe of mannekrag nie. Bevordering van die een kan dus geensins afbreuk aan die van die ander doen nie.

Beskou 'n mens die logistiek van veeartsenykundige opleiding in die breë uit 'n onbevange oogpunt, dan kan die volgende oplossing as die ekonomies, prakties en akademies mees aanvaarbare aan die hand gedoen word. Bou 'n nuwe fakulteit op die proefplaasterrein van die Universiteit Pretoria en oorhandig die bestaande fakulteitskompleks aan Bantoe-Onderwys. Met hierdie klip in die bos word voorlopig volstaan.

Jl S. Afr. vet Ass. 44 (4) : 349—350 1973

EDITORIAL

PROTEINS AND ECONOMICS

It is difficult to understand how a situation develops whereby financial gain leads to economic stagnation, and yet this is envisaged to be the developing trend in the animal industry.

Protein inadequacy was recognized in cattle feeding from the days of the initial phosphate experiments and with the current intensification programmes of production it is a major limiting factor in animal feeding, be it in the production of broilers, baconers, beef or mutton.

The main protein supplements for animal feeds in the Republic are fish meal, oil cake meals and carcase meal, the latest production figures of 1972 in metric tons being 202 840, 150 577 and 8 338 respectively. It is significant to note that just on half of the fish meal produced (106 473 tons) was utilized locally at a fixed price of just over R106,00 per ton. The current local factory price has risen to a fixed R173,00 per metric ton, whereas the overseas price is fluctuating around R350,00*. The disparity between the local and overseas price is substantial, even when allowing for transport and handling charges. This price differential encourages efforts to export even of the fraction ear-tagged for use on the local market.

The question asked is, for how long can South Africa afford the luxury of this irreplaceable loss of an essential raw product, which is exported to gain ± 25 million rands' worth of foreign exchange. The exports have precipitated a drastic local protein shortage for use in animal feeds, with the result that high protein concentrate formulations have been discontinued by several feed companies. The situation will continue, and even be aggravated; as long as this inequality of price structure exists and the channels for direct or indirect export of fish meal remain open. (The latter could readily be effected by ex-

*By February 1974 these prices had risen to R200 and R419.

REDAKSIONEEL

EIWITTE EN LANDSEKONOMIE

Dit is moeilik om 'n toestand te begryp waardeur finansiële wins tot ekonomiese stagnasie lei, maar dit word voorsien as die neiging, wat in die vee-industrie aan die ontwikkel is, toegelaat word om voort te duur.

Eiwit-ontoereikendheid in die voer van vee is reeds in die dae van die eerste fosfaatproewe herken en met die huidige intensivering van produksieskemas is dit een van die belangrikste beperkende faktore in dierevoeding, of dit nou die produksie van braaihoenders, ham, bees- of skaapvleis geld.

In die Republiek is die belangrikste byvoegings tot voer vismeel, oliekoekmeel en karkasmeel; die jongste produksiesyfers vir 1972 is 202 840, 150 577 en 8 338 metrieke ton onderskeidelik. Dis betekenisvol dat net bykans die helfte van die geproduseerde vismeel (106 473 ton) plaaslik verbruik is teen 'n vasgestelde prys van net oor die R106,00 per ton. Die plaaslike fabrieksprys het tot 'n vasgestelde R173,00 per metrieke ton gestyg, terwyl die oorsese prys om en by die R350,00 wissel*. Selfs toegelaat vir vervoer- en hanteerkoste, is die verskil aansienlik. Hierdie prysverskil moedig die uitvoer aan van selfs dié deel aangewys vir plaaslike bemarking.

Die vraag ontstaan nou, hoe lank kan Suid-Afrika die weelde van hierdie onvervangbare verlies van 'n essensiële grondstof, wat uitgevoer word om 25 miljoen rand se vreemde valuta te verdien, bekostig. Die uitvoer het 'n ernstige plaaslike eiwittekort bespoedig, gevolglik het reeds etlike veevoerfabrikante vervaardiging van hoë-eiwitkonsentrate gestaak. Die toestand sal voortduur en selfs vererger word, so lank hierdie ongelykheid in prysstruktuur bestaan en die kanale vir direkte of indirekte uitvoer van vismeel oop is. (Laasgenoemde kan geredelik bewerkstelling word deur uitvoer van eenvoudige formulerings wat grotendeels vismeel bevat).

*Teen Februarie 1974 het hierdie pryse tot R200 en R419 gestyg.

port of simple formulations consisting mainly of fish meal.)

The progressive increases in meat price— 37,7% rise of the average of all grades between August 1972 and August 1973 — are a stimulus for increased production, but at the same time long term investment is discouraged by the uncertainty of the protein situation, which is having a stifling effect. The abattoirs are receiving disturbingly large consignments of unfinished cattle and sheep, including large numbers of immature females, which are being marketed off the veld. The females should still be on the farms to increase the stagnant animal population, whereas the unfinished cattle and sheep could be marketed after a period of intensive feeding to increase weights and grades which would benefit the consignor.

The country's meat requirements are currently being met with the assistance of imports from adjoining territories. Exports are being maintained for 'academic' interest only. The European Economic Community and adjoining countries are consuming meat at prices ranging from 1,5 to 2,5 times our local prices and the demand, hence price, is continually increasing. On the local markets the consumer population has changed dramatically: the wages of the lower income worker have nearly doubled in the last year and if 17 million people eat meat twice a week instead of once, the market supply is strained to its limits!

If the protein shortage is relieved, the stimulus for greater production of quality meat will eventually more than off-set the initial loss of foreign exchange by virtue of exports of a final product. At the same time abundant energy sources (roughage and grain) will be marketed via a higher priced article. Nevertheless, the fish meal producers must be assured of their future as they are the geese that lay the golden eggs and we must guarantee their economic welfare.

The question arises whether health aspects and economics are related, and whether the veterinary profession should in any way be involved in the economics of the animal industry. Could it also be that the prosperity of the veterinary profession is dependent on the bouyancy of the animal industry? Even more important, is the profession not co-guardian of that industry?

Die progressiewe styging in vleispryse — 37,7% in die gemiddelde prys van alle grade tussen Augustus 1972 en Augustus 1973 — dien as spoorslag vir verhoogde produksie, maar terselfdertyd word langtermyn-belegging ontmoedig deur die onsekerheid van eiwitlewering, met sy knellende uitwerking. Die slagplase kry ontstellende groot besendings onafgeronde beeste en skape, insluitende groot aantalle jong, vroulike diere, wat direk van die veld bemark word. Die vroulike diere behoort op die plase te bly om die stilstand in dierebevolkingsaanwas teen te gaan, terwyl onafgeronde beeste en skape bemark kon word na 'n periode van intensiewe opvoer om gewigte en grade te verhoog ten bate van die sender.

Die land se vleisbenodigdhede word huidig verkry deur invoer van omliggende gebiede. Uitvoere word slegs om „akademiese" redes aan die gang gehou. Die Europese Ekonomiese Gemeenskap en aanliggende lande verbruik vleis teen pryse wat 1,5 tot 2,5 keer hoër is as plaaslike pryse en die aanvraag styg steeds. Op die plaaslike markte het die verbruikersbevolking ingrypend verander: die lone van die laer-inkomste-groep het sinds verlede jaar byna verdubbel; as 17 miljoen mense tweemaal per week in plaas van eenmaal vleis eet, sal die markvoorsiening tot die uiterste belas wees!

Indien die eiwit tekort verlig word, sal die aansporing tot hoër produksie van kwaliteitsvleis uiteindelik die aanvanklike verlies van buitelandse betaalmiddele meer as vergoed omrede uitvoere van 'n finale produk. Terselfdertyd sal oorvloedige energiebronne (ruvoer en graan) bemark word deur 'n kommoditeit van hoër prys. Desnieteenstaande moet vismeelprodusente van 'n toekoms verseker word: hulle is die ganse wat die goue eiers lê en ons moet hulle hul ekonomiese welvaart waarborg.

Die vraag ontstaan of gesondheids- en ekonomiese vraagstukke met mekaar verband hou en of die veeartsenykundige professie hoegenaamd by die ekonomie van die veenywerheid betrek moet word: is die welvaart van die veeartsenykundige professie dan nie afhanklik van die kragtigheid van die veenywerheid nie, nog belangriker, is ons professie dan nie medevoog van hierdie nywerheid nie?

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REVIEW

OORSIG

THE DEVELOPMENT AND PHYSICAL STRUCTURE OF MUSCLE COLLAGEN IN RELATION TO MEAT TOUGHNESS*

R. BOCCARD**

SUMMARY

The rôle played by collagen in contributing towards tenderness or toughness of meat is evaluated and briefly outlined, as well as its physical structure, biochemical nature, synthesis and the changes concomitant with age. The various methods of measuring collagen content are mentioned in historical perspective, as well as those used for determining its stage of development, including ultimately that of degree of polymerization by means of measuring maximum contractile force at given temperature as a true measure of age. Practical ways of improving tenderness are considered.

INTRODUCTION

At a time when many people have insufficient protein in their diet and experts predict a general shortage of meat, even in those countries which traditionally are over supplied, it would seem unrealistic to undertake research on quality and not to confine all efforts to that on quantity. But it is not possible to reduce human satisfaction merely to quantity. Psychologically, and even physiologically, eating is more than feeding, hence knowledge how to prevent spoilage and wastage and to maintain or eventually increase the organoleptic qualities of human food during storage and processing must be improved. The latter two aspects will become more important in future as a result of the ever increasing concentration of consumers who will be less and less able to prepare their own meals.

Meat has always played an important rôle in human nutrition. With the evolution of social conditions people tend to eat more meat and less vegetable protein. Meat eating is a status symbol with a long tradition behind it. Now traditions have been forgotten and only the idea remains that meat is really an indispensable food.

Consumers require quality and are willing to pay more for food meat than for other sources of protein. Consumers prefer meat with a high lean to fat ratio, a bright red colour, and which is tender and tasty. The two first attributes of quality, i.e., lean to fat ratio and colour, can be judged upon purchase. They are commercially important, especially in prepackaged meat sold in shops where nobody can influence the house-wife's decisions. Flavour and tenderness contribute directly to the satisfaction of the consumer. Tenderness is the first factor, and if the meat is too tough (or not well cooked) the flavour cannot be appreciated. Of the organoleptic characteristics of meat, tenderness is certainly the most important.

MEASUREMENT OF TOUGHNESS/TENDERNESS

'As paradoxical as it may seem, studies on the causes of toughness are hampered by lack of fully reliable methods of measuring tenderness, while the development of such methods is seriously handicapped by the incomplete basic knowledge of the underlying principles of tenderness' [18]. Numerous methods have been developed to measure tenderness and toughness. The oldest method is the consumption of meat samples. Scientifically developed, this is presently known as taste panel assessment. It is certainly the best method but the validity of the panel's evaluations depends on the training and the sensory accuracy of the judges, who must be selected carefully. The same panel must be kept throughout the entire test and all panel members must be present at each session. In order to improve accuracy, the number of members of the panel is increased, making it more difficult to muster all the members. Consequently physical measurements are often preferred. The operation of the various instruments used for evaluating meat tenderness is based on the same variety of methods

*Address delivered at the Animal and Dairy Science Research Institute, Irene, South Africa, on 23 February, 1973.

**Station de Recherches sur la Viande, I.N.R.A., THEIX, 63110 Beaumont, France.

by which the study of physical properties of material is done: shearing, puncturing, biting and mincing.

Among the many instruments developed for measuring tenderness, the Warner Bratzler (W.B.) shear forces apparatus is extremely popular and is being used extensively. Extensive comparisons have been made between W.B. shear force values and taste panel assessments of toughness. Correlation values are highest where the scale of variation is wide. When only one tender muscle, e.g., the commonly selected *m. longissimus dorsi*, is used as the parameter of tenderness, the variation between different experimental states or treatments, such as age, breed and cooking, is small and the correlation with taste panel results is low. Another reason for the poor correlations sometimes obtained is the fact that members of a taste panel do not display a continuous and linear scale in their judgement with increasing or decreasing tenderness. Above certain values of toughness, especially, the subjective assessment does not vary very much. This is the reason why, for example, the Armed Forces and Containers Institute in the U.S.A. found 'that data of Warner Bratzler as a measure of tenderness were more sensitive than sensory evaluation'[18]. There are some limitations and continuous endeavour are made to design a device which would be more sensitive and yield more reproducible results. Many instruments have been proposed, some of them very sophisticated, but, in spite of this, the Warner Bratzler remains the simplest and quickest to use. It has facilitated an increase of knowledge of the nature and variations of tenderness.

FACTORS DETERMINING TOUGHNESS/TENDERNESS

The factors involved and the various characteristics of toughness of meat have been studied by using panel evaluation and mechanical measurements. Many components of this parameter of quality have been discovered.

Briefly toughness depends upon:

1. fibre diameter and bundle size;
2. contractile and sarcoplasmic proteins;
3. amount, nature and distribution of connective tissue.

Extensive studies have yielded some justification for assuming a measure of correlation between the first and third factors.

RIGOR MORTIS

The transformation of live muscle into meat is a long and complex process, in which contractile proteins and sarcoplasmic components are involved[10]. The main reaction which occurs in muscles after killing and bleeding of animals is the progressive breakdown of ATP. As long as resynthesis of ATP can maintain its level above 2 mol per gram of muscle, 'lubrication' of the rods takes place and the muscle remains flexible. Subsequently it progressively loses it extensibility. Finally the muscle is in *rigor mortis*. The time of onset of *rigor mortis* depends on the physiological status, process of handling and slaughtering, and methods and conditions of storage. In general, *rigor mortis* in beef is completed between 12 and 24 hours *post mortem*. At this stage the contractile proteins actin and myosin are combined, the muscle is hard and inextensible and the meat is at its maximum toughness. During storage of carcasses or meat, the toughness associated with *rigor mortis* is gradually reversed as the period of *post rigor* conditioning increases. These changes are not connected with the sliding of actin and myosin filaments but with the breakdown of the attachment of the extremities of actin at the base of the sarcomere, namely at the Z-line[19]. This hydrolysis, caused mainly by intrinsic muscle cathepsins released by lysosomes, improves the tenderness at a rate which varies between muscles, between animals — especially on account of their age and sex — and the conditions and temperatures of storage. The improvement of tenderness during storage has been well known for a long time. It was first studied scientifically by Lehmann in 1907[16] and systematically by Ramsbottom & Strandine in 1949[17]. This improvement of tenderness is limited: even with long and special storage many muscles of the carcass remain too tough to be eaten after quick cooking. Since the time of Lehmann[16] this residual toughness has been attributed to the connective tissue which remains unattacked by the hydrolytic enzyme system of muscle during the normal storage of meat.

CONNECTIVE TISSUE

Initially connective tissue content was evaluated by determination of the amount of nitrogen in the gelatine produced after autoclaving. Subsequently that part of the muscle which was insoluble in alkaline solu-

tions was determined. For the past twenty years connective tissue content has been measured by the determination of hydroxyproline in its collagen.

The relationship between toughness of ripened meat and connective tissue content has been, and still is, the subject of intensive study, especially because accurate and quick methods are now available for measuring this component of muscle. Considerable controversy exists: many workers have found no correlation or very low correlations between collagen content, measured by hydroxyproline or other methods, and tenderness; numerous others have reported the opposite. These conflicting results need some explanation. The first set of workers usually obtained their data on one muscle only, which generally was a tender muscle, namely part of the *longissimus dorsi*, easily sampled at the normal commercial cut between the hind and forequarter. Under these circumstances the variation in tenderness, and possibly of collagen content, is narrow, so that the correlation between them is of a low order. The conclusion of Hunsley and his co-workers [12]: "Collagen, measured as hydroxyproline, was not a critical measure of tenderness in *longissimus dorsi* of beef", is thus readily appreciated. Other research workers, who believe that connective tissue has an influence on toughness, have studied it on several different muscles. The most representative selection of samples has not yet been determined; the best solution is to have tender, medium and tough muscles. In most of our studies we have taken the *mm. psoas major, longissimus dorsi, semitendinosus, semimembranosus, pectoralis profundus* and *triceps brachii*. This procedure is unfortunately very costly and one should attempt to obtain a good scale of tenderness in the forequarter only or even in that part of it considered to be of the lowest value: shoulder, brisket and neck. The *m. teres major* is very near the tenderness of the *m. psoas major*, but it is very small.

In studies of this nature the correlation between shear value and amount of hydroxyproline of each sample of raw meat may approach values of 0,8 [3]. These values are highly significant, but the whole variation of toughness at a given age cannot be explained by the connective tissue only. Other factors which would most probably also have an influence are the nature, structure and distribution of the connective tissue, of which many specific properties have been studied recently.

PROPERTIES OF CONNECTIVE TISSUE

Connective tissue is not a true tissue but more a labyrinthine compartment of the body. It is composed of specialized cells surrounded by fibres and amorphous ground substance. The cells may simply be described as belonging to the fibroblast, macrophage and mast cell family. There is abundant evidence that fibroblasts are responsible for the bio-synthesis of both the acid mucopolysaccharides of the ground substance as well as of the fibres (collagen and elastin). Connective tissue in muscle is present in four anatomical and histological forms. Surrounding the muscles as a whole is a sheath, known as the epimysium (deep fascia). From it septa of connective tissue (the perimysium) penetrate the muscle to group together bundles of muscle fibres and through which pass the large blood vessels and nerves. Finally the network is completed around each muscle fibre by a fine sheath of connective tissue, the endomysium. All these structural units of muscle connective tissue blend at the extremities of the muscle where they are attached to the bone directly, or by a massive aggregate of connective tissue fibres forming the tendon. The collagen, which represents more than 50% in weight of the total connective tissue, is the most significant part to consider.

COLLAGEN

The term collagen is used to describe a family of fibrous proteins widely distributed throughout the animal kingdom. At the various microscopic, electron microscopic and X-ray diffraction pattern levels collagen appears to have a uniform molecular structure in all mammals. At the light microscopic level, fibres of varying thickness up to about 20 μm thick can be seen. They are subdivided in fibrils of 0,3 to 0,5 μm in diameter. With the electron microscope filaments of 20 nm to 100 nm thick are observed. They display a succession of light and dark bands regularly spread along the fibril. This pattern is repeated every 64 nm, a periodicity ascribed to the staggered arrangement of tropocollagen molecules, each about 280 nm long, and lying end to end in parallel strands. Bear [1] is of the opinion that this pattern is the consequence of the superimposition of polar and non-polar parts inside the molecular chain. The polar region would be amorphous with numerous side chains. The opposite non-polar region without side chains is more regular

and it is called cristallin. The region is built up mainly by the non-polar amino acids. They give the helical conformation to the chain and constitute a large proportion of the total amount of amino acids.

The amino acid composition of many collagens originating from various animal sources in general have the following characteristics:

—a high proportion of glycine (25 — 30%)
—a very small quantity of tyrosine, almost no sulphur amino groups (no (S-S bridges) and no tryptophane;
—large quantities of proline and hydroxyproline.

Hydroxyproline can be found only in protein of the collagen family. A small quantity of it is also present in elastin, but many authors regard this as a pollution by collagen during the process of extraction. The hydroxyproline content is usually between 12,5 and 14% of the total mass. Owing to these exclusive properties of muscle collagen, it is possible to detect its presence in any product and to measure its quantity by the specific determination of hydroxyproline, a coëfficient of conversion of between 7,5 and 8 being used as a rule. The explanation for the specific presence of hydroxyproline and hydroxylysine in collagen must be sought in the synthesis of collagen.

SYNTHESIS OF COLLAGEN

Extracellular collagen, like other proteins, is synthesized intracellularly at the ribosomal level.[8] The synthesis begins at the N-terminal end known as telopeptide. This part contains the greatest proportion of the polar amino acids, especially tyrosine and lysine residues. The synthesis continues along the regular part of the chain where glycine and proline are fitted in regular and fixed sequence, interrupted from time to time by another residue. No hydroxyproline can be fitted into the chain: there is no soluble RNA to transport this amino acid. After a period of synthesis yielding a definte length of the chain, hydroxylation of the second proline of the tripeptide glycine-proline-proline occurs. This hydroxylation, undertaken by a specific enzyme hydroxylase in the presence of Fe of Cu ions, requires atmospheric oxygen (from the respiratory system), ascorbic acid and a certain amount of alphaketoglutarate. If for any reason, such as lack of one of the necessary compounds, the hydroxylation ceases, the synthesis is stopped. The hydroxylation of some lysine residue to give hydroxylysine may follow the same route as hydroxyproline, even if in this case oxygen is supplied by water.

After the hydroxylation of proline and lysine, a mole of carbohydrate (generally a galactose) is normally added onto the chain on aspartic or lysine residue. Other carbohydrates, such as glucuronic acid or different acetyle hexoses, are fixed on the first carbohydrate, giving hyaluronic acid, chondroitin sulphate, heparin, etc. They are all elements of mucopolysaccharides. The whole process of synthesis of this component of collagen takes less than five minutes. Two forms of this elementary polypeptide chain are produced, named α_1 and α_2. Their molecular weight is nearly 95 000. They have a very similar structure, except in their N terminal end where the telopeptide displays some difference in the amino acid composition. Inside the fibroblasts these two types of chains join, mainly by hydrogen bonds, to yield the molecules of collagen called tropocollagen. This molecule, weighing 300,000 is composed of two α_1 chains and one α_2 chain. It is often called $\gamma_{1,1,2}$. (A component consisting of two α_1 chains is known as $\beta_{1,1}$. If made up of an α_1 and an α_2 chain, it is known as $\beta_{1,2}$.).

Before being released by the fibroblast, some part of the molecule is changed This is the beginning of the aging of collagen, which will progressively modify the chemical and physical properties of this protein. These processes take place in three steps inside the fibroblasts.

1. An enzyme, lysyloxidase removes the amino group from lysine or hydroxylysine and donates an aldehyde group. This deamination-oxidation requires the presence of copper salts. The lysyloxidase, the first factor in aging, is strongly inhibited by β amino propionitrile (β APN). This compound is found in the seeds of *Lathyrus sativum* and is a cause of the connective tissue disease lathyrism.
2. In the second step of maturation of collagen, one aldehyde group can react with another to give an aldol group or with an amino group (lysine or hydroxylysine) to yield a Schiff's base. These two types of linkages are established between polypeptide chains of the same molecule of tropocollagen, or between different molecules, side

by side or end to end. The aldehyde group can be blocked by penicillamine or semicarbazide. The Schiff's base can be broken by dilute acids, eg. acetic acid, in which case the collagen is regarded as acid soluble.

3. The third step, of which the exact nature is not yet well established, is the stabilization of these linkages, so that the Schiff's base becomes resistant to breakdown by dilute acids and bases. Mucopolysaccharides participate in this stabilization, especially by new linkages, but also by steric protection of the polypeptide chain. This point is important for the enzymatic attack on collagen *in situ*.

The aging of collagen by the increase in number of cross links results in a radical modification of its physical and physiological properties. In this process can be found not only the basis of aging and of many diseases of animals, man included, but some explanation for the development of toughness of meat. With the progress of polymerization, resulting in increased aggregates, collagen becomes progressively less able to swell when heated in water, and its solubility and ability to gelatinize decrease.

From a technological point of view, the swelling and solubility is the most interesting and relevant aspect to be studied. Direct measurement of the degree of polymerization is difficult. It is generally accepted that the proportion of soluble collagen in different types of solvents is related to cross-linking Numerous methods have been used to measure solubility. The first studies on meat were done on the total collagen in the muscle. In 1964 Goll *et al*[7] found that the labile muscular collagen in cattle varied from 41% at two weeks of age to as low as 2% at 10 years. Hill[11], in 1966, confirmed that less collagen becomes soluble when cooking meat from old than from young animals. The solubilization of total muscle collagen, however, is not quite accurate enough to understand and to predict its state of development. Different solvents at different levels of pH and ionic strength have been used to separate collagen into fractions with different degrees of polymerization, as indicated by their solubility in neutral, acid or alkaline medium, or their insolubility. The proportions vary largely with age[13] (Fig. 1).

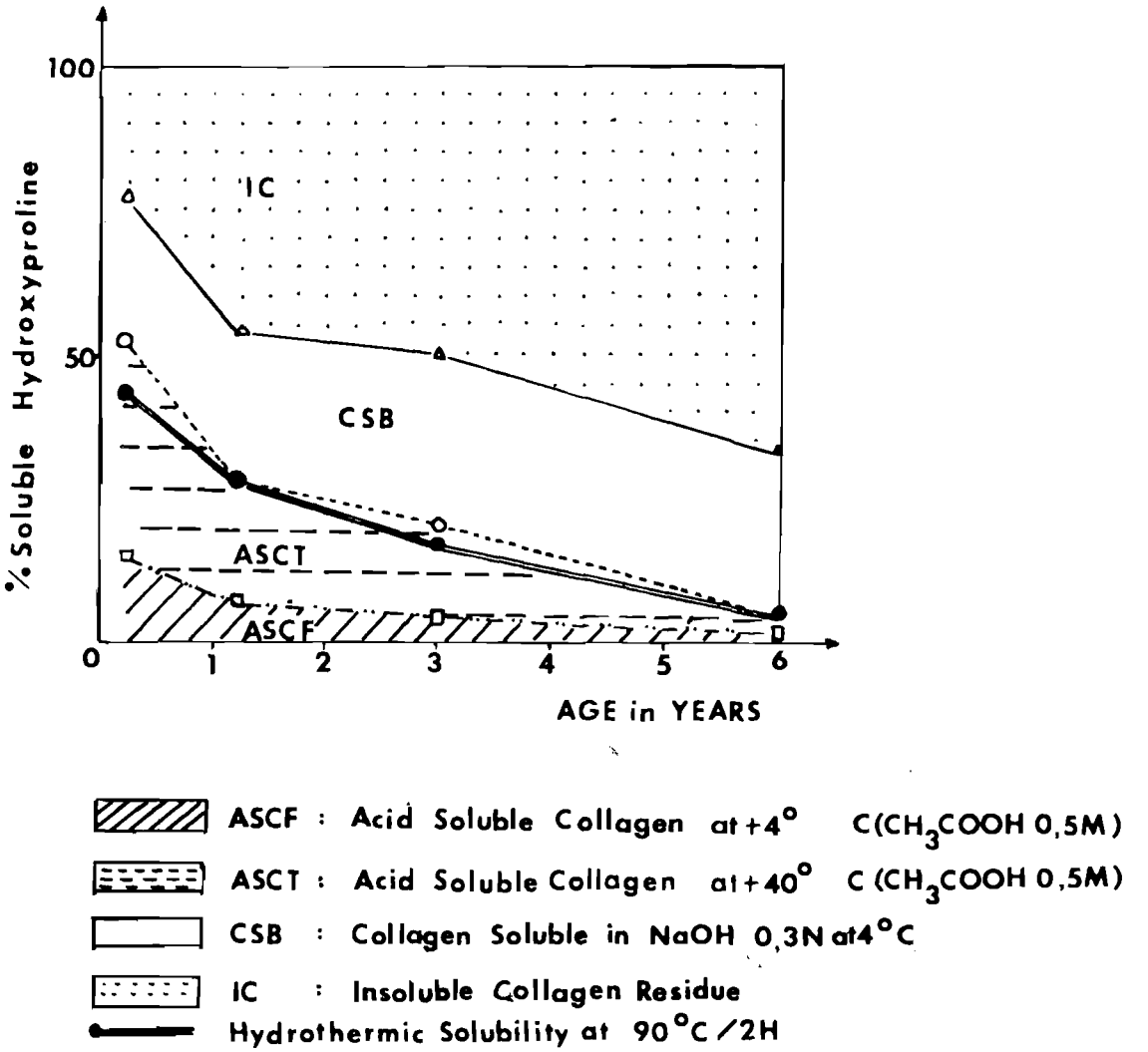

Fig. 1a: The change in solubility of collagen in the endomysium of the M. longissimus dorsi of beef cattle of different ages [13].

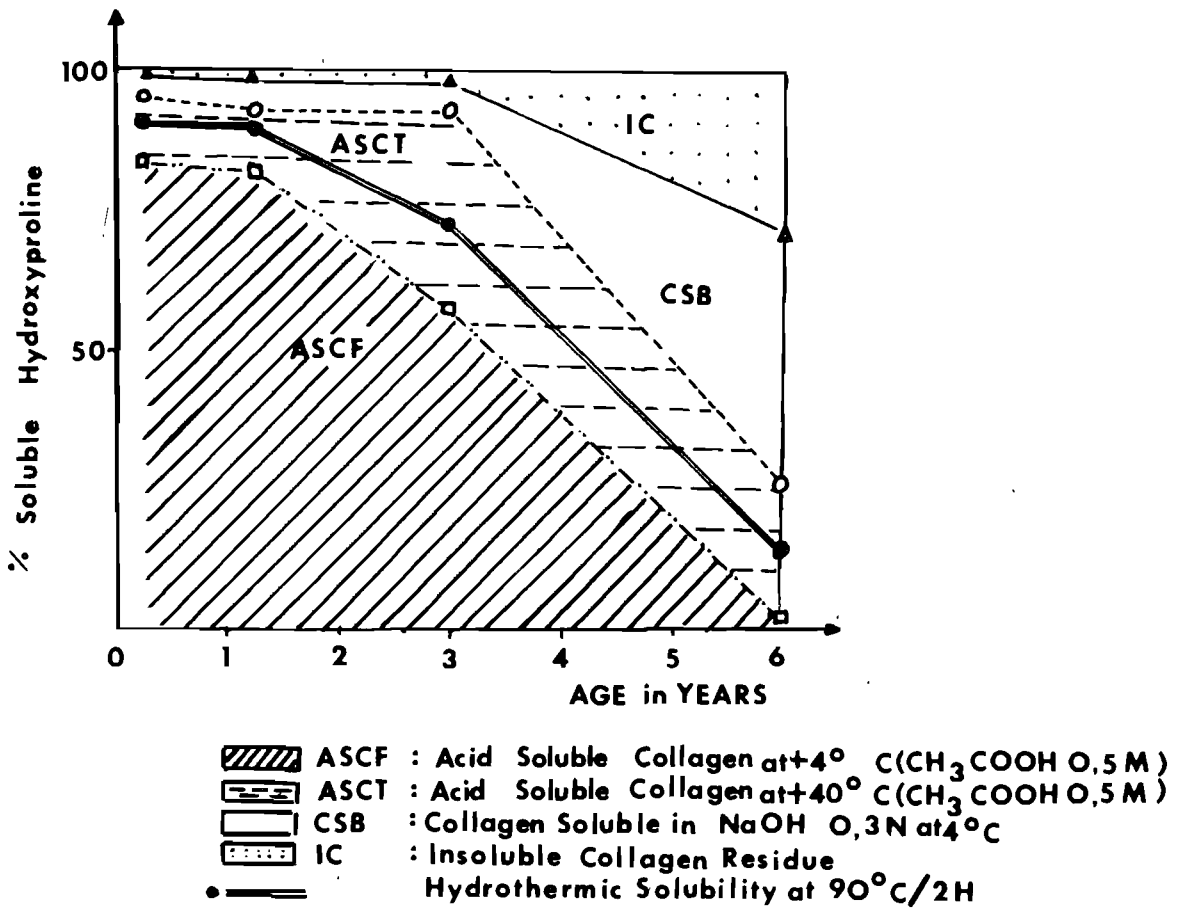

Fig. 1b: The change in solubility of collagen in the e pimysium of the M. longissimus dorsi of beef cattle of different ages [13].

Collagen from different sites in muscle behave differently and age at different rates. Epimysial and intramuscular collagen present two different curves of development [4]. Kopp [13] similarly found the same variation in developmental pattern with different forms of collagen in beef. Solubility appears to vary according to the conditions of cooking, viz temperature and ionic strength (Fig. 2). These are very important factors to consider

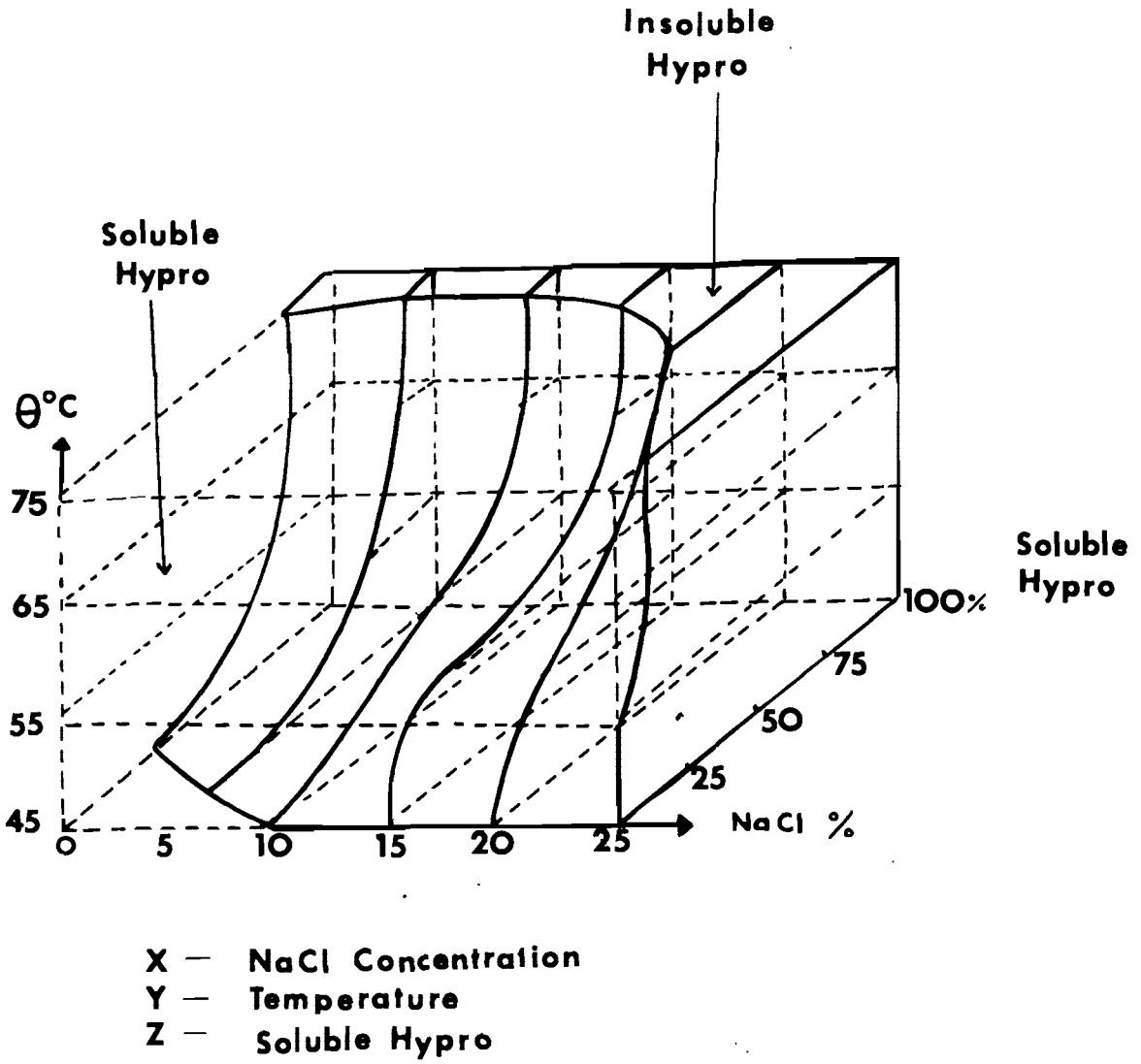

Fig. 2: The hydrothermal solubility of epimysium collagen from the M. longissimus dorsi of pigs, after three hours of different heat treatments in solutions of different ionic concentrations [15].

during processing, because all the collagen extracted does not undergo the same degree of renaturation after it has been cooked and the gelatine obtained may have different physical properties. The cohesion of the products is largely affected, as in a slice of ham, for instance.

In fresh meat prepared by the same dry cooking procedure a direct but low relationship between tenderness and solubility of collagen has been established [3]. This point is important, but the main interest in solubility is its influence on tenderness of meat in water cooking procedures. As more molecules of water are introduced between the collagen chains, more collagen can swell and be removed, and hence the more tender is the meat.

Another aspect of collagen in dry cooking conditions is its shrinkage in direct relation to toughness. When collagen fibres are heated to a certain temperature, generally 60°C, the structure is changed by rupture of the thermolabile linkages (mainly the H-bonds) and the fibres contract. This contraction reduces the length of fibres to 30 to 40% of their original length. Therefore when cooking meat, a general shrinkage of the collagen network occurs. The pressure inside the piece of meat increases and some sarcoplasmic proteins and water are pressed out. The meat is less juicy and tougher. The consequences of heating is more important in muscle with a high than with a low collagen content. This property is partly reversible; cold meat is more tender than warm meat. This physical property is related to the degree of polymerization, which is generally studied using fibres in isometric state, although in meat the isotonic state generally prevails. Measurements are then made of the force developed and the temperature at the maximum strength [15] (Fig. 3).

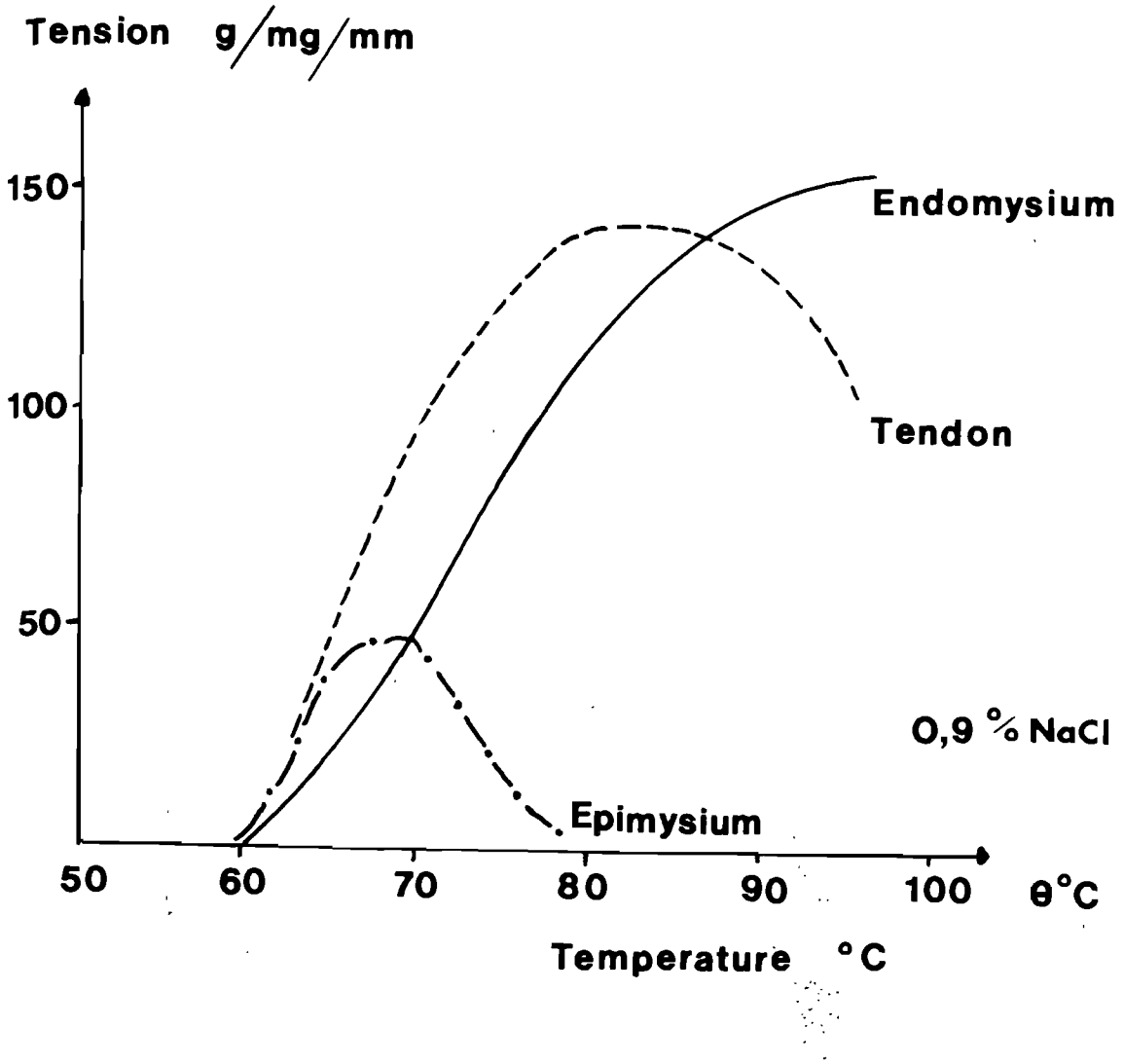

Fig. 3: Isometric hydrothermal contraction of three types of collagen fibrils obtained from three-months-old calves [15].

These measurements are now used more often because physical measurements are generally quicker and more accurate than chemical methods. From the curve obtained by plotting temperature against maximum force attained, the number of linkages of different types may be calculated. This constitutes the true measure of age (Fig. 4).

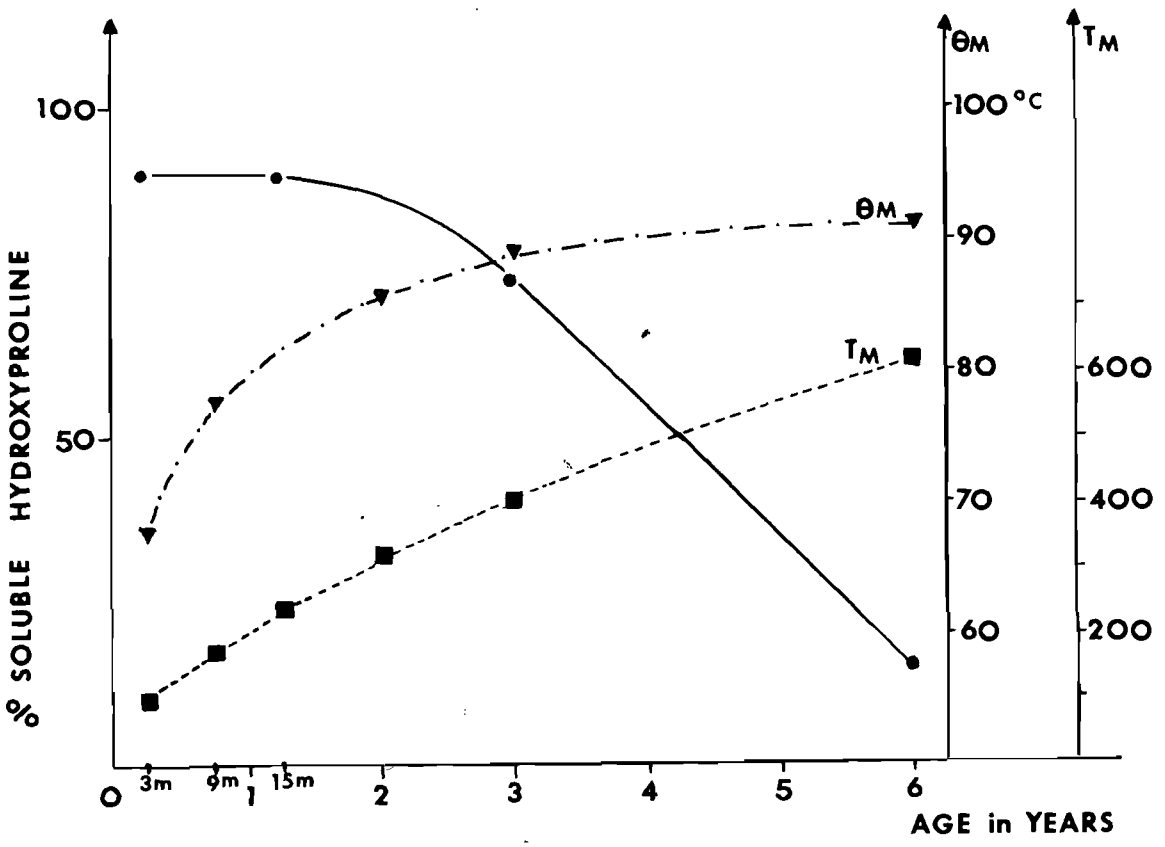

Fig. 4: Changes which occur with age of beef cattle in the physical properties of the epimysium collagen of the M. longissimus dorsi [13].

The cooking process must be adapted to the collagen content and its nature, i.e. its stage of polymerization. With a low content of young collagen, quick, dry cooking yields tender meat. With a higher content of young collagen, a short period of cooking in water will be sufficient to obtain tender meat. As the age and quantity of collagen increase, cooking should be done in water and the time allowed longer to reach optimal tenderness.

IMPROVEMENT OF TENDERNESS

If it is true that 'there is no tough meat but only meat not well cooked', the consumer must be assisted by supplying him with meat which is easy to cook. The improvement of tenderness can be achieved by one of two means:

1. decreasing the connective tissue content, and
2. increasing the collagen solubility, biologically or by technological processing.

The decrease of tenderness with age has induced breeders to produce fat animals at much younger ages. But when considering their income and the carcass grading system, they are compelled to sell heavy animals. In order to reach a correct mass at a young age, breeders have to change their breeding system: and they have to increase the nutritional level of the cattle and they have to produce bulls instead of steers. Entire males produce more lean meat with less fat and have a higher rate of growth.

The amount of connective tissue in the muscle of entire male is very similar to that of steers. Some workers have reported slightly higher content in bulls, but the solubility of collagen is undoubtedly better than that of steers of the same weight. Bull meat can be cooked quickly in water. More research is necessary, however, to clarify the development of collagen in bulls of different breeds and crosses.

Since a decrease in collagen content of muscle cannot be attained by decreasing the age at slaughter, biological variation of collagen content between breeds as a result of congenital defects may be employed. The collagen content of porcine muscles of the Piétrain and large White breeds varies markedly. The absolute difference between these breeds is greater between muscles containing the greater amount of collagen [2]. The same deviation in the properties of collagen is found in the muscles of double-muscled beef animals and this can be utilized technologically. These animals have a high dresssing percentage, which is due mainly to a thin skin. Their conformation is very good and the muscle to bone ratio is high. The hypertrophy of muscles is not general but mainly peripheral [6]. All the muscles contain less collagen and are more tender [5]. A study of the muscle collagen in double-muscled animals has shown that it has a normal structure. Only the synthesis or its location in connective tissue is disturbed. If it is too difficult to breed homozygote strains of this type of cattle, the use of double-muscled bulls on normal cows is proposed.

Biological means of altering the collagen synthesis are limited, hence many research workers attempt to prevent the formation of collagen or at least to decrease its rate of aging. The efficient use of β amino propionitrile or pencillamine is too expensive. The best way in the near future will most probably be to use specific enzymes on collagen, but not in living animals. It should be applied directly to tough meat of which the collagen content is too high. The use of papain has been proposed, but its action is not specific for collagen. Specific collagenases are presently under investigation but their use is limited by the fact that they are extracted from pathogenic strains of bacteria or in very small quantities, e.g. from *Hypoderma bovis*. Mincing will perhaps be the final solution to obtain universal tenderness. This can be followed by the addition of flavours and by compressing and freezing. All meat could then be sold in this way. Even though this now seems to be the end of good eating, it will most probably be the way in which meat will be consumed by the people of many countries in the future.

ACKNOWLEDGEMENT

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PROGESTERONE CONCENTRATION IN THE PERIPHERAL PLASMA OF THE MARE DURING THE OESTROUS CYCLE AND EARLY PREGNANCY

C. H. VAN NIEKERK, J. C. MORGENTHAL, C. P. SANDERS AND J. E. MALAN*

SUMMARY

Progesterone concentrations were assayed by a competitive protein-binding technique in peripheral plasma samples collected twice daily during four oestrous cycles of three mares, and once a day during the first seven weeks of pregnancy in four mares. Large variations were found in progesterone levels between morning and evening samples on the same day in the same mare.

The lowest progesterone concentration was found about the time of ovulation. Within 24 hours after ovulation the progesterone concentration increased and two peaks, one at 5 days and another at 8 days, were found. Between 10 and 14 days after ovulation the progesterone level decreased steadily with a rapid drop between Days 14 and 16 (4 days before ovulation).

A progesterone peak, possibly 17α-hydroxyprogesterone, was found just before ovulation.

During the first 10 days after ovulation the progesterone concentration of pregnant and non-pregnant mares was more or less similar. Between Days 10 and 14 there was also a decline in concentration in pregnant mares but between Day 17 and 30 there was a rise. This rise was once again followed by a decrease, at first gradual and then rapid, during the last few days before ovulation, which occurred on an average at 42 days. Shortly after this, the concentration once again rose rapidly.

The cyclic changes in the progesterone concentration closely follow the cylic changes in the macro- and microscopic morphology of the *corpus luteum* and the follicular activity of the ovaries.

INTRODUCTION

Irregularity of the oestrous cycle and disturbance of endocrine function appear to be the major causes of low fertility in mares. Until recently the endocrinology of the oestrous cycle and pregnancy in the mare was studied mainly on follicular fluid and luteal tissue obtained from slaughtered animals or by biopsy [22, 23, 24, 38, 40]. One major disadvantage of this type of sampling is that it is either impossible or impractical to follow the hormonal status of individual mares throughout the cycle or pregnancy. Moreover, progesterone concentration of the *corpus luteum* is an indirect and certainly not a true indication of the hormonal level in peripheral blood.

The fairly recent development of sensitive assay procedures — especially those based on radiometric principles — enabled research workers to study the level of hormone such as progesterone more intensively than before, particularly as it is now possible to use small volumes of biological fluids sampled at frequent intervals. Thus the progesterone content of peripheral plasma of the mare has been the subject of a number of investigations [5, 17, 25, 7].

The mare is unique in that marked ovarian activity occurs during early pregnancy. Fully matured follicles of up to five cm in diameter were found between the 17th and 25th day *post coitum*, and although ovulation did not occur in these mares, ten per cent of them showed behavioural oestrus [33]. Evidence that true ovulation does occur between the 40th to 50th day of pregnancy was furnished by various research workers [2, 3, 7, 9, 38].

The hormonal regulation of this singular ing in the peripheral blood, *inter alia*, during the first few weeks of gestation is as yet unexplained, owing mainly to total lack of information on the hormonal levels prevailing in the peripheral blood, *inter alia*, during early pregnancy.

The purpose of this experiment was to determine peripheral plasma progesterone concentrations in the peripheral blood of mares during the normal oestrous cycle and early pregnancy, and to correlate progeste-

*Department of Animal Physiology, Faculty of Agriculture, University of Stellenbosch. Submitted: July 4, 1973.

rone levels with behavioural oestrus, ovarian activity and ovulation.

MATERIAL AND METHODS

Animals

Five clinically normal breeding mares, of which two were of the light farm type and the rest Percheron mares, were used in this experiment within the local breeding season during January to March, 1972.

The mares were kept on the experimental farm, Elsenburg, in the winter rainfall area of the Republic of South Africa, under the same environmental conditions and on the same balanced ration. From about three weeks before the beginning of the experiment, a mature stallion was used daily to identify mares in oestrus, which was increased to twice daily — in the morning and the evening — during oestrus and the following oestrous cycle. Follicular development and time of ovulation were determined by rectal palpation of the ovaries twice daily (in the morning and the evening) during the oestrous period, but only once daily during the interoestral period. A fertile stallion served three mares after one complete oestrous period while the other two were served during the second oestrous period. After the mares were served, the teasing procedure and rectal examination continued daily for a period of 55 days after ovulation.

Twice daily, at 07h00 and 17h000, 45 ml jugular blood was collected in heparin from each mare during the oestrous cycle. After a mare had ovulated, the same volume of blood was withdrawn once a day at 07h00 for ± 50 days after ovulation. Within one hour after collection the heparinized blood samples were centrifuged, and the plasma was stored at -20°C until assayed.

Measurement of Plasma Progesterone

Solvents: Analytical grade absolute ethanol, methanol, benzene, diethylether, ethyl acetate (E. Merck, Darmstadt), iso-octane (2,2,4-trimethylpentane — B.D.H.) and petroleum ether, B.P. 40 — 60°C (E. Merck; May and Baker; B.D.H.) with the exception of ethyl acetate, were used without further purification. Ethyl acetate was glass-distilled before use.

Steroids: Non-radioactive progesterone was obtained from E. Merck. Corticosterone — 1, 2—^{3}H (SA : 36 Ci/mmol) and progesterone — 1, 2—^{3}H (SA : 14, 6 Ci/mmol) were purchased from The Radiochemical Centre, Amersham, England. The tritiated steroids were used without purification.

Scintillation medium: Scintillator for counting tritium was prepared by dissolving 12 g PPO (Packard), 200 g naphthalene (scintillation grade, E. Merck) and 0,55 g dimethyl POPOP (Packard) in 2 l 1,4 dioxane (scintillation grade, E, Merck).

Liquid scintillation counter: The Beckman LS — 133 liquid scintillation system was used.

Dextran-coated charcoal suspension (DCC): The charcoal suspension for the separation of bound and free isotope was prepared by adding and mixing 5 mg Dextran T4D (Pharmacia Ltd.) and 500 mg charcoal (Norit A, Sigma) to 200 ml Tris — HCl buffer (pH 8.0). Stored at 4°C, it remained effective for at least 2 weeks.

Buffer solution: The buffer solution was prepared by dissolving 2,42 g Tris hydroxymethyl methylamine (Koch-Light Laboratories Ltd.), i.e., Tris in 100 ml of freshly distilled, deionized water, to which was added 80 ml N HCl, 170 g sucrose (Protea Laboratory Services) and 0,584 g diaminoethanetetraacetic acid disodium salt (BDH), thereafter made up to 2 l and the pH adjusted to pH 8,0.

Standard progesterone solutions: Standard solutions of progesterone were prepared as described previously [39].

Preparation of the protein-binding solution (CBG-B^{3}H): Plasma as a source of corticosterone-binding globulin was obtained by exsanguinating a clinically normal, adult dog into heparinized containers. After centrifugation the plasma was divided into 4 ml aliquots and stored at 15°C. The CBG-corticosterone- 1, 2—^{3}H was prepared by diluting 3 ml of the dog plasma to 100 ml, to which 20 nCi of tritiated corticosterone in 400 µl ethanol was added. After gentle mixing, the protein solution was kept 4°C for 24 hours before use. The CBG-B^{3}H solution remained stable for at least 3 weeks if stored at 4°C.

Chromatographic materials: Celite, Grade I, was obtained from Sigma and analytical quality ethylene glycol from E. Merck. The microcolumns comprised ordinary 2 ml glass syringe barrels. In general the celite was purified and the columns packed according to Korenman, Tulchinsky & Eaton [15].

A minor modification was the use of a small wad of ether-washed non-absorbent cotton wool to support the celite in the syringe barrel.

Extraction and purification of the plasma extracts: Twenty volumes of diethyl ether were used to extract 0,5 ml plasma in a 15 ml

conical test tube on a Whirlimixer (Fisons Scientific Co. Ltd., U.K.) for 30 seconds. The ether was withdrawn by pipette, washed with 1 ml glass-distilled water, transferred to a third tube in which it was dried over anhydrous sodium sulphate, and evaporated under a stream of air at 45°C in a waterbath.

The dried extract was reconstituted in 2 ml iso-octane and quantitavely transferred to the celite column[29], which had been pre-washed with an equal volume of the same solvent. This procedure was repeated twice. Elution of the column was performed by vacuum as follows. The outlet of the syringe barrel containing the celite column was fitted tightly to a vacuum flask connected to an electrical vacuum pump. By connecting a series of flasks, each with a fitting for a syringe barrel, to the pump, it was possible to elute a total of four columns simultaneously. The total of six ml iso-octane containing the extract was eluted directly into a glass tube and afterwards evaporated under a stream of air at 45°C.

Competitive protein-binding assay (CPB): To each of the tubes containing the dried iso-octane fraction was added 200 μl Tris-HCl buffer, while six duplicated additional tubes received 200 μl aliquots of buffer solution containing 0; 1; 2; 3; 4 and 5 ng progesterone. A volume of 200 μl CBG-B^{3}H was pipetted to both sample and standard tubes, mixed briefly on the Whirlimixer and placed in a 45°C waterbath for 10 minutes, after which the tubes were transferred to an ice bath for a similar length of time.

At the end of this 10 minute period 0,5 ml DCC suspension was added to each tube, the contents mixed again, and thereafter allowed to stand in the ice bath for a further five minutes before centrifugation at 3 000 r/min for three minutes. The clear supernatant of each tube was finally decanted into a counting vial containing 10 ml scintillation fluid. The vials were counted for a sufficient length of time to render a counting error of less than two per cent.

Standard displacement curves, one of which accompanied every batch of samples were constructed by plotting the mass of progesterone in the standard solutions against the per cent bound tritiated corticosterone, as depicted in figure 1. Each point in this representative curve represents the mean ± standard deviation (shown by the vertical bars) of 38 determinations assayed over several months using the same batch of dog plasma. The standard deviations of the means — which were on average 3,6% for the five levels of progesterons — are an indication of the between-curve variations.

Evaluation of the method: CBG is not specific to progesterone[16, 19], but of the steroids eluted in the iso-octane and 15% ethyl acetate in iso-octane fractions[28, 29], it is only progesterone (pregn-4-ene-3,20-dione), 17-αhydroxyprogesterone (17-αhydroxy-pregn-4-ene 3,20-dione), and deoxycorticosterone (21-hydroxy-pregn-4-3,20-dione) which compete significantly with tritiated corticosterone on dog plasma. The rest either does not displace progesterone from dog CBG or, as in the case of 20-αdihydroxyprogesterone (20-αhydroxy-pregn-4-en-3-one), only weakly so[30].

The blank value for plasma, stripped of endogenous steroids as described previously[20], was 0,25 ± 0,13 (S.D.) ng/0,5 ml (n = 13). The recovery of tritiated progesterone added to the celite column in six ml iso-octane and eluted in exactly the same way as for the sample extracts was 76,6 ± 10,3 (S.D.) (n = 9), while the recovery of 5 ng unlabelled progesterone added to 0,5 ml stripped plasma after extraction, celite chromatography and CPB assay was 74,3 ± 3,26 (S.D.) % (n = 12).

Results were not corrected for procedural losses.

Briefly a preliminary investigation with a view to ascertain the presence of 17-αhydroxyprogesterone (17-OHP) was carried out by applying ether extracts of the particular samples to methanol pre-washed silica gel thin layer plates containing a fluorescent indicator (E. Merck, Darmstadt). The plates were developed by ascending chromatography in benzene : ether (1 : 1v/v), the authentic 17-OHP (Steraloids, Pawling, New York) visualized under ultra violet light (Rf. values: progesterone — 0,67; 17-OHP — 0,42; and cortisol — 0,06), areas corresponding to 17-OHP spots eluted and subjected to CPB assay in which the progesterone standards had been replaced by 17-OHP. Results indicated that a steroid with a similar Rf value, and with similar binding characteristics to CBG as 17-OHP was present in easily detectable concentrations.

Stone, Kharma, Nakamura, Mishell & Thorneycroft[29] indicated that 17-OHP is eluted from the celite column by 10% ethyl acetate in iso-octane. This elution pattern could have been altered by the slight modifications adopted in this study, and the elution of the

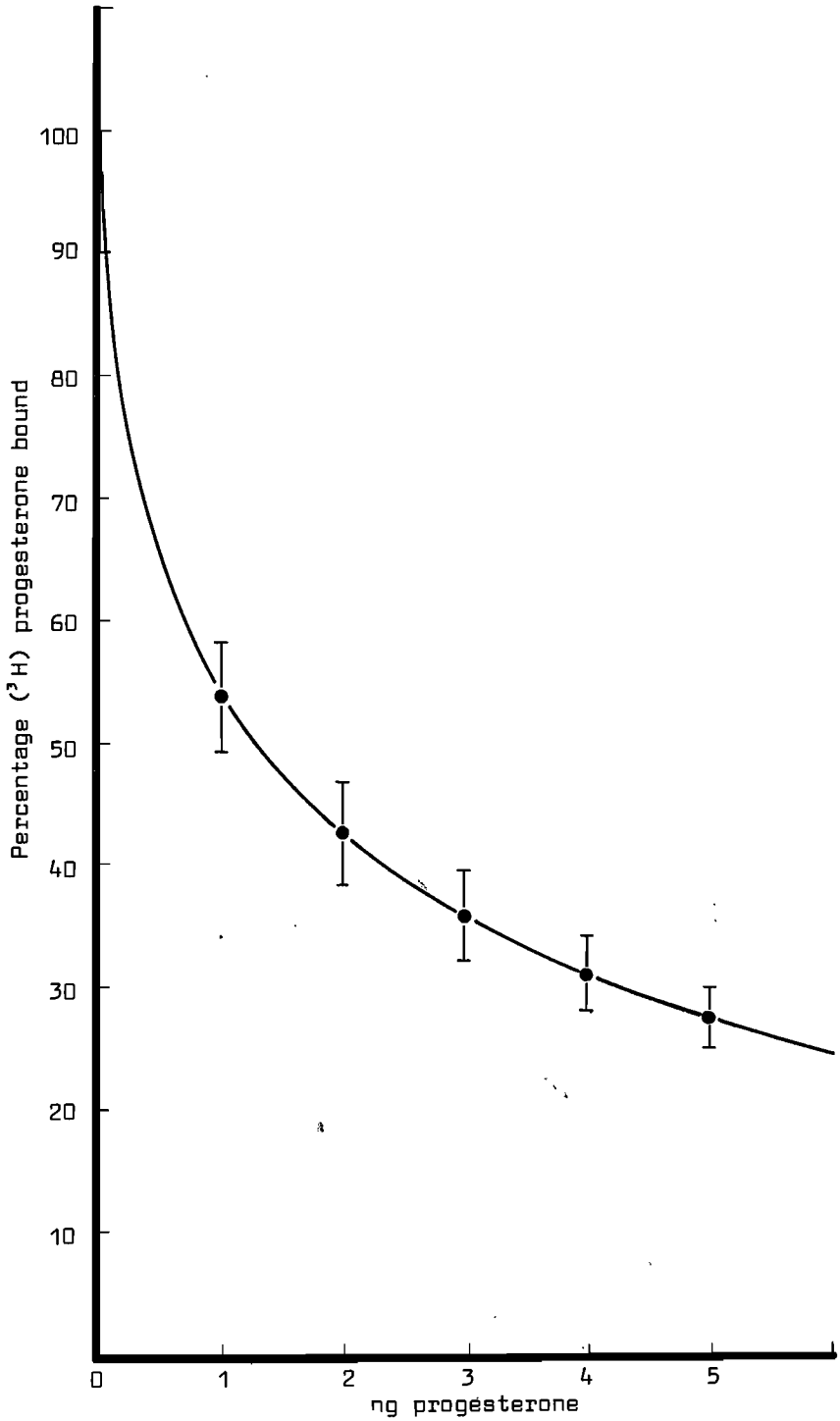

Fig. 1: Reproducibility of the standard curve for progesterone. Means and standard deviations for the points of 39 standard curves are shown.

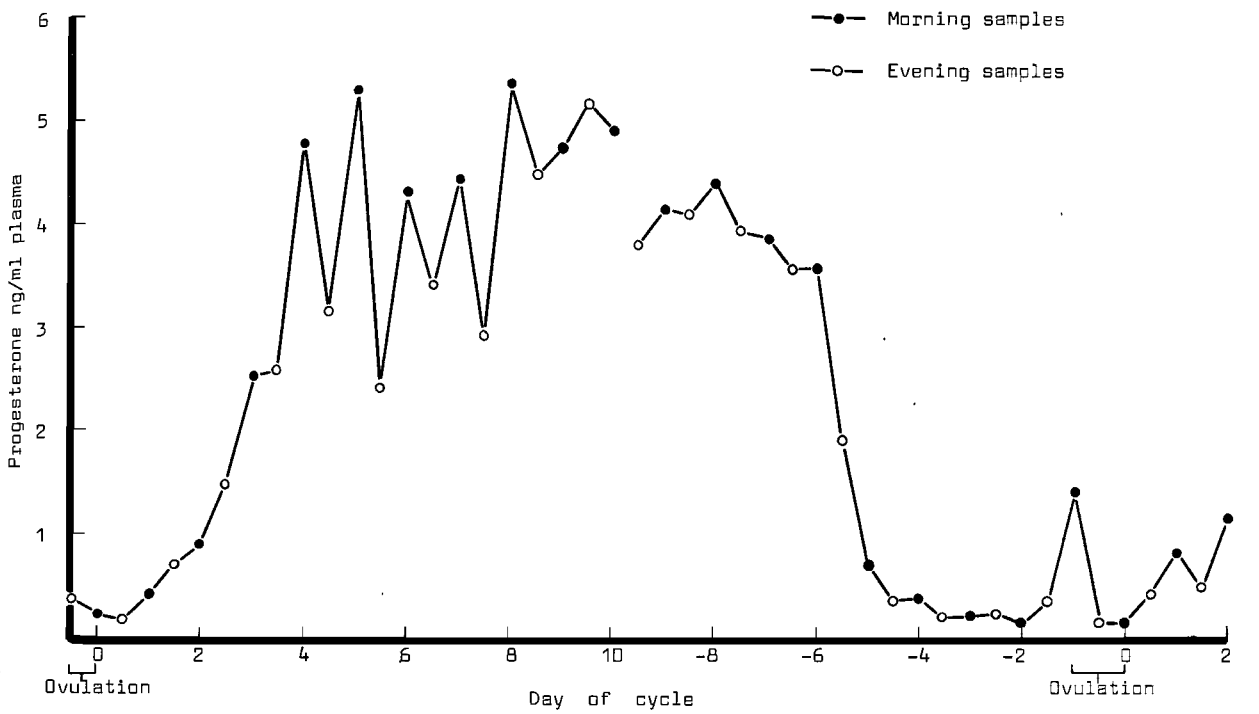

Fig. 2: Mean plasma concentrations in mares during four oestrous cycles.

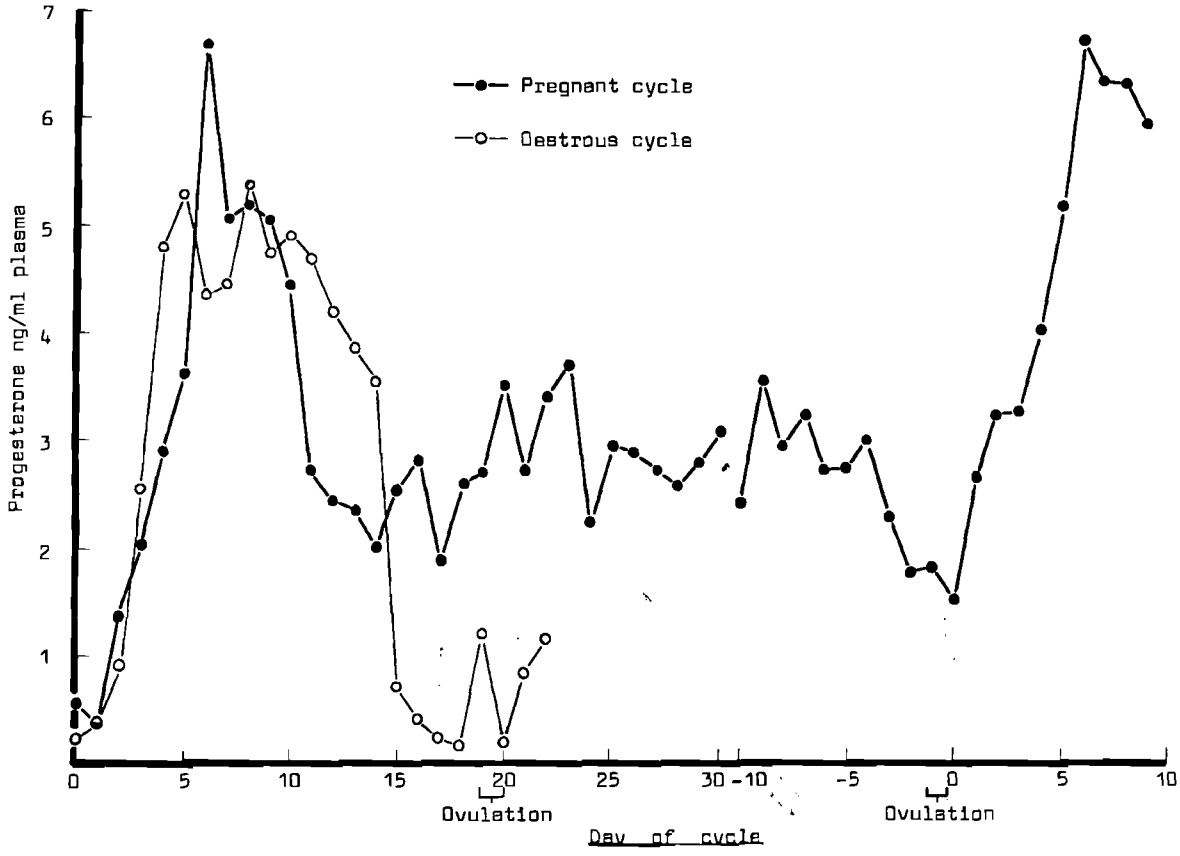

Fig. 3: Mean plasma progesterone concentrations in mares during four oestrous cycles and during four early pregnancies.

steroid was tested by adding varying quantities of 17-OHP to the columns after which it was eluted in exactly the same way as described in the Material and Methods section. The dried iso-octane eluate was subjected to CPB assay against 17-OHP standard as before, and from the results it is apparent that some 17-OHP is indeed eluted in the iso-octane fraction.

RESULTS

The mean length of the total of four oestrous cycles recorded for the three mares was 21 ± 1,0 days (S.D.), and during these cycles ovulation occurred within three to five days (mean: four days) from the beginning of oestrus.

The mean concentrations of peripheral plasma progesterone sampled during four oestrous cycles are shown in figure 2. In order to combine data from different cycle lengths, the day of ovulation was taken as Day 0 of the cycle with the days following ovulation numbered from two to 10; the 10 days preceding the next ovulation were retrospectively designated 10, -8, -6 and so forth to the ovulation of the next cycle, which was similarly taken as day 0. Progesterone concentrations were found to be at their lowest (0,1 — 0,2 ng/ml, which was within the lowest effective limits of the standard curve) immediately after ovulation. Within one to two days after ovulation an increase in progesterone levels was observed in all the mares. It rose rapidly thereafter, reaching maximal concentrations of about 5,3 ng/ml within four to five days after ovulation, after which it declined slightly to lower average levels on the sixth and seventh days before rising to a second peak of 5,4 ng/ml on the eighth day. A gradual decreasing trend was evident from about the 10th day to average levels of 3,5 ng/ml on the 14th day (i.e. six days before the following ovulation, Day -6 in fig. 2). Between Days -6 and -4 of the cycle it fell sharply to 0,4 ng/ml and, with the exception of a solitary elevation which reached a mean of 1,4 ng/ml on the morning of Day -1, it tended to drift even lower to the vicinity of 0,2 ng/ml, which was, again, within the sensitivity limits of the standard curve. After ovulation it remained at these low levels for one to two days before the occurrence of a rapid post-ovulatory rise which resembled the increasing concentrations described for the beginning of the previous cycle.

Of considerable importance is the as yet unreported rhythmic variation in progesterone concentrations of peripheral plasma collected respectively in the morning and the evening during the luteal phase, which is apparent in fig. 2. The values for morning samples were found to be consistently and considerably higher than in the evening over at least five successive days of the 12 days of the cycle during which the hormone was maintained at elevated levels. Variations of up to 3,0 ng/ml were recorded on the same day.

Figure 3 illustrates the average daily progestrone concentrations of peripheral plasma samples collected in the morning of the first ± 50 days of pregnancy. The graph is superimposed upon the average daily values of the normal non-pregnant oestrous cycle of fig. 2, of which only the morning samples were taken into account.

The two primary points of reference in fig. 3 were, firstly, the first day of ovulation from which pregnancy originated and secondly, the day of the first ovulation recorded during pregnancy. While both were taken as Day 0, the former is followed in fig. 3 by days numbered from 5 to 30; the latter is preceded by days numbered retrospectively -10, -5 and 0. The first 10 days after the first ovulation in pregnancy were numbered normally from 5 to 10. This arrangement was necessitated by the fact that the time of the first ovulation during pregnancy varied considerably for the four mares (36th to 50th day, mean: 42nd day).

It is evident from fig. 3 that the progesterone levels of the oestrous and pregnant cycles followed approximately the same pattern up to Day 14, whereafter concentrations for the oestrous cycle dropped rapidly while pregnancy levels remained fairly constant with its lowest level on Day 17. Between Day 17 and 23 a progressive increase in pregnancy concentrations were recorded, followed by a slight decline. Between Days 24 and 27 the values remained practically constant — although on a somewhat lower level — before exhibiting an increasing tendency through the 30th day after ovulation to Day -9. This ninth day before ovulation, on the 42nd day of pregnancy, was followed by declining progesterone concentration in a slow, fluctuating manner for the first five days, but in a much more abrupt way during the last few days preceding ovulation. This pattern over the last 9 days before ovulation during pregnancy had less

pronounced but very similar tendencies to those followed by the hormone during the last 9 to 10 days before ovulation in the non-pregnant oestrous cycle.

The hormone increased rapidly in concentration immediately after ovulation, to attain a mean peak value of 6,76 ng/ml on the sixth day, which was the 48th day of pregnancy. The trend, and the time it took to reach maximal levels, closely resembled the pattern followed after ovulation in both the non-pregnant as well as the early pregnant mare.

DISCUSSION

Results of this study confirmed the data on the peripheral plasma concentrations of progesterone during the normal oestrous cycle described in the literature [5, 17, 25, 27]. The average concentration of progesterone reported here appears to be approximately 25% lower than values previously reported, but it can be explained by the fact that present results have not been corrected for procedural losses.

During the oestrous cycle, progesterone concentrations were found to be at their lowest for a period of about 24 hours after ovulation, which coincided with the time the mare remained on heat. The rapidly rising progesterone values observed after the post-ovulatory period were accompanied by an increase in the mass and progsterone content of the *corpus* luteum [36, 38]. According to Van Rensburg & Van Niekerk [38] luteal progesterone is detectable as early as 18 hours after ovulation, but it is only at about the 24th hour when an increase is observed. In the plasma the abrupt elevation of progesterone values from after Day 1 to the peak on Day 5 is in agreement with previous reports [5, 17, 25, 27].

After the 5th day of the cycle progesterone values remained high, although at slightly lower levels. A second peak on the 7th day concurs with the findings of Smith, Bassett & Williams.[25]

From the results of the histological study by Van Niekerk [36] it is apparent that the increasing progesterone concentrations during the first six days of the cycle are a reflection of enlarging granulosa (luteal) cells [12]. First signs of degeneration of luteal cells were recorded on the 12th day. It was seen to continue gradually to Day 14, after which degenerative changes accelerated to such an extent that most luteal cells were found to be affected by Day 16. The cellular degeneration of the *corpus luteum* [36] coincided with declining levels of luteal [38] and plasma progesterone (Fig. 2).

The first clinical signs of oestrus were observed in all mares as soon as plasma progestrone had fallen to below 0,5 ng/ml, which was, on average, four days prior to ovulation of the next cycle. An interesting observation during this stage of the cycle, which in general was characterized by low progesterone concentrations, was the appearance of a solitary, short-lasting, small, yet consistent peak which is difficult to explain in terms of progesterone. The time of its appearance in the cycle, however, approximates the stage of the menstrual cycle in woman when 17-α-hydroxyprogesterone (17-OHP) rises to peak levels, i.e. one day prior to, on the day, or one day after the occurence of the LH-FSH mid-cycle peak [1]. Moreover, in the mare it is known that the fluid of the mature follicle contains considerable quantities of this particular steroid during oestrus prior to ovulation [22, 23, 24, 40]. This consideration resulted firstly, in an attempt to ascertain the presence of 17-OHP in the plasma samples corresponding to the appearance of the peak in question, and, secondly, in a re-examination of the ability of the celite column to separate progesterone from 17-OHP.

A preliminary investigation with a view to ascertain the presence of 17-OHP was carried out. These preliminary investigations strongly suggest the possibility that the small peak occurring within 12 to 24 hours before ovulation represented the appearance of 17-OHP in peripheral blood. This observation, however, requires confirmation.

Of considerable interest is the relatively large difference in progesterone concentrations between morning and evening plasma samples, which has not yet been described in the horse. This diurnal variation was recorded on five successive days during the luteal phase of the cycle when the mean concentrations in the morning samples were significantly higher than in the evening ($P < 0,025$). Differences of up to 3 ng/ml were recorded on the same day, which serves as an indication that for investigations of this nature, daily samples should always be collected at the same time. It could, perhaps, partially explain the considerable variations in progesterone found by other workers [17].

With regard to progesterone concentrations in the peripheral plasma of mares during early pregnancy, no comparable data could be found in the literature, while in-

formation on luteal progesterone is limited to work of Van Rensburg & Van Niekerk,[38] and Short[24].

From fig. 3 it is evident that progesterone appears in the blood of the mare during early pregnancy in an undulating pattern characterized by major peaks between the 6th and the 10th day, the 20th and the 23rd day, the 30th and the 32nd day, and again on the 6th day following ovulation during pregnancy. Similarly Van Rensburg & Van Niekerk[38] reported that follicular growth and oestradiol synthesis occurred in waves of follicular activity, the first of which started at about the 12th, the second on the 22nd and the third on the 32nd day of pregnancy. If these findings are compared with the progesterone curve of early pregnancy presented in fig. 3, it is apparent that the respective waves of follicular activity correspond reasonably well with those stages of pregnancy during which progesterone levels were found to be in a state of decline.

The rapidly decreasing levels of plasma progesterone recorded between the 10th and the 14th day of both oestrous cycle and pregnancy coincided with decreasing luteal progesterone value[38], as well as a reduction in the mass of the *corpus luteum* of pregnancy[36]. The pronounced drop in progesterone concentrations from the 10th to the 14th day of both pregnancy and the cycle appears to be peculiar to the mare, in that similar observations are not described in other species such as bovine[10,13,18,21], ovine[4,11,26], caprine[31], porcine[32], or the guinea-pig[6], nor in the human[14].

After the 14th day, cyclic plasma progesterone values continued to fall, but in pregnancy the declining progesterone concentration was arrested at a level of about 2 ng/ml — approximately 60% less than the mean for Day 4 to Day 9. While the cyclic values remained relatively low from the 16th to the 20th day, pregnancy levels were maintained at higher concentrations during the same period. The mean difference in progesterone concentrations for pregnant and cyclic mares during this period proved to be very highly significant ($P < 0{,}001$), and this is directly related to the difference in uterine tone and wall thickness between pregnant and non-pregnant mares described by Van Niekerk[33,34], who suggested that this difference in uterine morphology could be employed as a diagnostic method for pregnancy between 16 and 20 days.

For a period of nine days before the occurrence of ovulation on Day 42 of pregnancy, plasma progesterone decreased in concentration — at first rather slowly, but for the last four days considerably more rapidly (Fig. 3) — which is in agreement with the observations of Van Rensburg & Van Niekerk[38] regarding luteal progesterone and the attendant fall in luteal mass[36].

The cyclic pattern followed by plasma progesterone during early pregnancy is largely substantiated by the results of ovarian histo-morphological studies by Van Niekerk[36]. When decreasing plasma progesterone concentration was observed between Days 10 and 20 and again between Days 33 and 42 (day of ovulation), a decrease in the percentage of large active lutein cells and an increase in the percentage of small resting lutein cells was recorded[36]. The ratio between the active and inactive cells was reversed when the progesterone concentration rose between Days 20 and 30. Degeneration of the lutein cells occurred[36] when a sharp decrease in the progesterone concentration was found between 38 and 42 days.

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ABSTRACTS UITTREKSELS

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WORTHINGTON R. W., MÜLDERS, MARIA S. G., McFARLANE I. S. & BECKER, DAPHNE. **Serological titres following vaccination of sheep and goats with B. melitensis Rev 1 vaccine.** P. 1—6

Rev 1 vaccination of sheep induced complement fixation titres to both **Brucella abortus** and **Brucella ovis** antigens, these complement fixing antibody titres were, however, higher with the **B. abortus** antigen. These titres generally fell to negative levels (below 1/20) within 5 to 6 months of vaccination. In goat Rev 1 vaccination induced complement fixation titres against **B. abortus** antigen, which fell to negative levels within 5 to 6 months. Agglutination at 37°C or 56°C, agglunation in 5% NaCl, and Coombs tests are less useful in vaccinated animals, as titres remain at positive levels for much longer periods after vaccination.

WORTHINGTON R. W., MÜLDERS, MARIA S. G., McFARLANE I. S. & BECKER, DAPHNE. **A serological investigation on adult cattle vaccinated with Brucella abortus strain 19.** P. 7—12

Serum antibody titres were followed for a period of two years in 99 beef and 29 dairy cows which had been vaccinated as adults with **B. abortus** strain 19. Agglutination titres remained above diagnostic levels throughout but complement fixation, mercaptoethanol agglutination and rivanol agglutination titres generally returned to negative levels within 6 months Coombs tests and agglunation at 56°C proved to be of limited value for recognizing antibody titres caused by vaccination.

WALKER, JANE B. & LAURENCE B. R. **Margaropus wileyi sp. nov. (Ixodoidea, Ixodidae), a new species of tick from the reticulated giraffe.** P. 13—22

Descriptions are given of the male and female of **Margaropus wileyi** sp. nov. collected from reticulated giraffe in Kenya. A key is given to the three species now known in the genus Margaropus and their differential diagnosis is discussed.

VAN WYK J. A. **Studies on schistosomiasis. 4. Differential staining of live and dead cercariae after immobilization with physostigmin.** P. 23—30

A modified eosin technique similar to that used for differential staining of live and dead spermatozoa stained dead remained colourless and transparent. Prior to exposure to the cercariae of **Schistosoma mattheei** red while those that were alive dye, live cercariae were immobilized with physostigmin, which was better for that purpose than five other substances tested.

The lowest concentration of physostigmin to immobilize cercariae quickly and effectively was found to be 3, 3 x 10-6 M.

WIESE I. H., BASSON N. C. J., BASSON P. A., NAUDÉ T. W. & MAARTENS B. P. **The toxicology and pathology of dieldrin and photodieldrin poisoning in two antelope species.** P. 31—40

Blesbuck (**Damaliscus dorcas phillipsi**) and springbuck (**Antidorcas marsupialis**) were found to be more susceptible to dieldrin and its photoisomer than any vertebrates reported on previously in the literature. In blesbuck the mean cumulative lethal dose of dieldrin at various dietary levels was 9,07 mg/kg and of photodieldrin 1,90 mg/kg. Under field conditions the calculated median lethal dose of photodieldrin to blesbuck was 1,21 mg/kg, to springbuck it was 3,97 mg/kg. In both species rams were more susceptible to photodieldrin than ewes. It was proved that antelope mortalities on veld sprayed with dieldrin for harvester termite (**Hodotermes mossambicus**) control was principally due to photodieldrin intoxication.

In addition to the usual violent nervous signs encountered in chlorinated hydrocarbon intoxication a dumb syndrome, in which blindness was rather characteristic, was seen, especially in field cases.

The pathological changes in the blesbuck and springbuck were similar. Degenerative lesions typical of various conditions, including chlorinated hydrocarbon poisoning, were encountered in the skeletal muscles, myocardium, kidneys and liver of cases of both dieldrin and photodieldrin poisoning. The severity and widespread nature of the lesions in the skeletal muscles and myocardium of natural cases were reminiscent of white muscle disease and capture myopathy. Congestion, oedema and glial swelling of the brain were constant features.

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SERUM IONIZED CALCIUM IN THE SHEEP: RELATION TO TOTAL PLASMA CALCIUM, BLOOD pH, TOTAL PLASMA PROTEINS AND PLASMA MAGNESIUM

P.C. BELONJE*

SUMMARY

The mean serum ionized calcium in 50 normal ewes was 1,14 ± 0,11 (S.D.) mmol/[± 4,57 ± 0,44 (S.D.) mg%] and constituted on average 46,95 ± 4,36 (S.D.) % of total calcium. Although there was a highly significant linear correlation ($P<0,01$) between ionized calcium and total calcium, this was not of a sufficiently high order to enable the prediction of ionized calcium from total calcium. There were no significant correlations between ionized calcium, or the ratio of ionized to total calcium, and blood pH, total plasma proteins and plasma magnesium.

INTRODUCTION

The development of a specific calcium selective ion-exchange electrode (Orion Model 99-20 Serum Calcium Flow-thru System and Model 801 Digital pH/mV meter) has made it possible to determine ionized calcium in serum. As this is the physiologically active component of total calcium, it was considered necessary to establish its level in normal sheep and its relationship to total calcium. Furthermore, as most of the non-ionized calcium in blood is bound to proteins and pH affects the ratio of bound to ionized calcium [7], and as an interrelationship between calcium and magnesium has been shown in ruminants [4, 8, 16], it was decided to include these analyses and determine their relationship to ionized calcium.

MATERIALS AND METHODS

1. *Animals*

Clinically healthy ewes which were either barren or within the first three weeks of pregnancy were used.

2. *Collection of Blood Specimens*

The animals were handled carefully to avoid excitement and bled in the standing position. The jugular vein was occluded only momentarily to locate it and then free-flowing blood was withdrawn anaerobically into a sterile, disposable syringe. The blood was transferred immediately to three glass tubes as follows: Firstly a 1,5 ml conical centrifuge tube was filled completely [5, 10] with blood and sealed quickly with a plastic film held in place with a rubber band and kept at ambient temperature for ionized calcium determination. The second tube of 0,75 ml capacity containing dry heparin and a small metal agitator, was then filled and sealed as above but placed on ice for pH determination. The remaining blood was placed in a 15 ml centrifuge tube containing dry heparin, mixed and centrifuged, the plasma to be used for total calcium, magnesium and plasma protein determinations.

3. *Analytical Methods*

a. *Ionized calcium:* The blood was allowed to coagulate for about an hour at ambient temperature and was then centrifuged at 3 500 r/min. for 20 minutes without disturbing the plastic seal, Serum was drawn into a 1 ml glass tuberculin syringe fitted with a 12 mm 26 gauge needle by piercing the seal and then pumped through the calcium electrode. The level of ionized calcium was determined by comparison with commercial standards‡. To 100 ml of each of these standards were added 0,06 g trypsin and three drops of 1 M triethanolamine [3].

The electrode was used only if the readings of the 1 and 2 mmol/*l* standards differed by at least 7,5 mV [3]. Furthermore, each specimen was bracketed by a 1 mmol/*l* standard and if the reading of the second standard did not return to within 0,2 mV of the first, the specimen

*Dept. Animal Physiology, University of Stellenbosch.

‡Blood calcium standards A, B and C; Orion Research Corp.

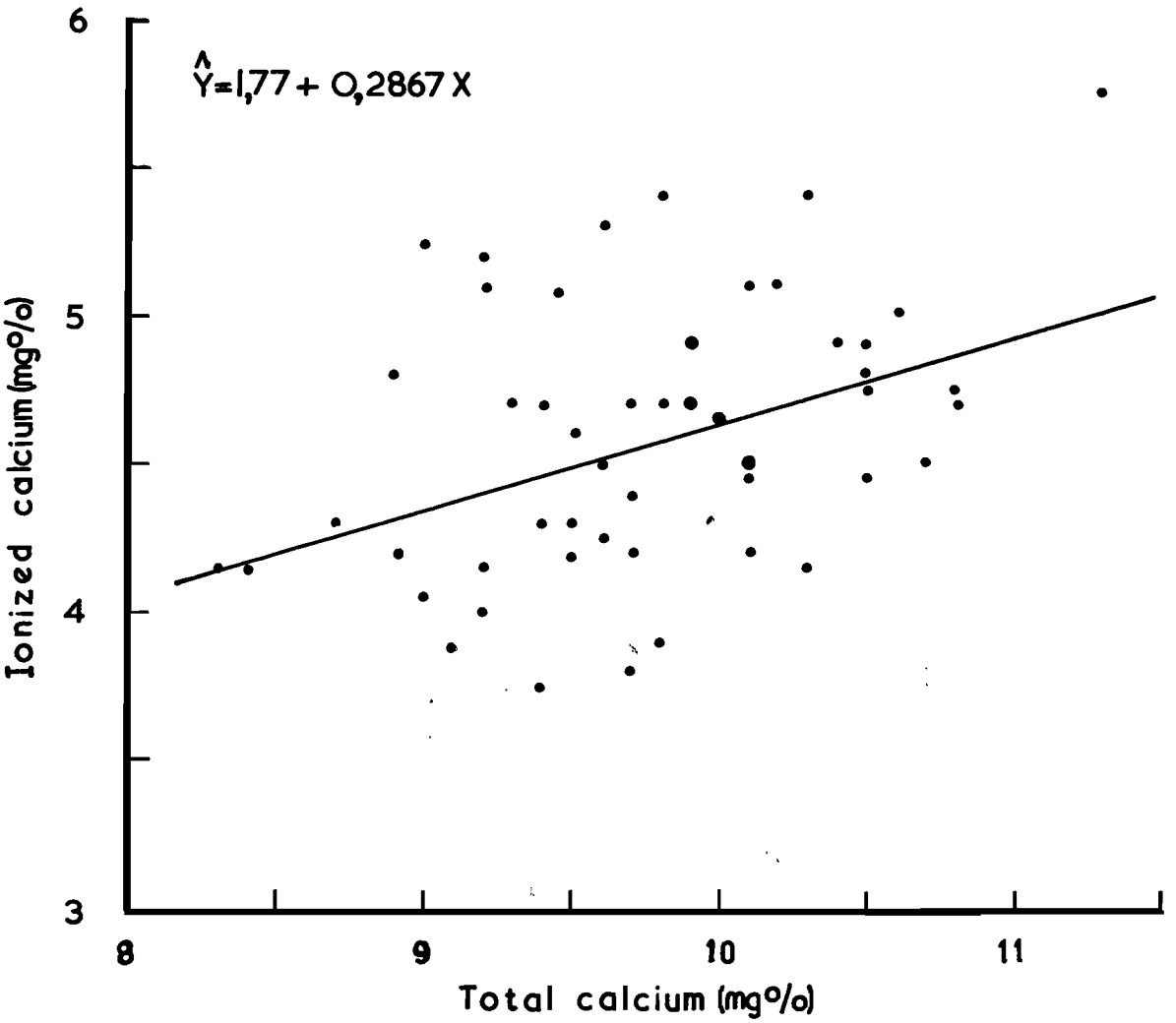

Fig.: The relationship between ionized calcium and total calcium.

was discarded. Specimens were also discarded if there was any indication that the plastic seal had been disturbed or damaged.

b. *pH determinations:* These were performed within 15 minutes of collection. Each tube was removed from the ice, shaken to mix the contents, and the blood was drawn into a micro pH electrode (Radiometer BMS 3) after puncturing of the plastic seal.

c. *Total plasma calcium and magnesium:* Plasma was diluted 1 in 20 with 0,1 per cent lanthanum chloride and compared with commercial standards (Hopkins and Williams) on a Perkin-Elmer model 303 digital readout atomic absorption spectrophotometer.

d. *Total plasma proteins:* These were analysed by the biuret method [18] and read on a Beckman model B spectrophotometer.

e. *Statistical methods:* Standard deviations, standard errors and correlations were performed as described by Snedecor & Cochran [17].

RESULTS

The results of the data obtained from 50 ewes are presented in table 1.

Table 1: THE MEANS, STANDARD DEVIATIONS AND STANDARD ERRORS OF THE VARIOUS DETERMINATIONS

Determination	Mean	Standard deviation	Standard error
Total calcium (TCa) m%	9,76	0,65	0,09
Ionized calcium (Ca^{++}) mg%	4,57	0,44	0,06
$Ca^{++}/T.Ca \times 100 = \%$	46,95	4,36	0,62
pH	7,351	0,055	0,008
Total plasma proteins g%	6,91	0,64	0,09
Magnesium mg%	2,25	0,21	0,03

As it is common practice to express total calcium in mg %, the same unit has been used here for ionized calcium. In order to express the latter in mmol/*l* the figures are divided by 4; hence, the mean ionized calcium in this group of animals is 1,14 $\pm$ 0,11 (S.D.) mmol/*l*. The range of the means of eight papers [1, 2, 5, 6, 9, 12, 13,15] presented on the ionized calcium in human serum was 0,97-1,24 mmol/*l*. This value for sheep falls well within this range.

The average percentage of total calcium which is ionized was found to be 46,95. Again, this is well within the range of 40,5 — 53,4 per cent reported for humans [2, 5, 7, 11, 12, 14].

The correlations between the various analyses are shown in table 2.

Table 2: CORRELATIONS BETWEEN IONIZED CALCIUM OR THE RATIO OF IONIZED CALCIUM TO TOTAL CALCIUM AND pH, TOTAL PLASMA PROTEINS AND MAGNESIUM

Correlation between	Correlation coefficient	
Ionized calcium (Ca^{++}) and total calcium (TCa)	0,4185**	
Ca^{++} and pH	−0,1681	NS
Ca^{++} and total plasma proteins	0,0232	NS
Ca^{++} and magnesium	0,0033	NS
Ratio Ca^{++} TCa and pH	0,1711	NS
Ratio Ca^{++}: TCa and total plasma proteins	−0,0010	NS
Ratio Ca^{++}: TCa and magnesium	−0,0173	NS

** = highly significant ($P < 0,01$)
NS = not significant

But for the highly significant correlation ($P < 0,01$) between ionized and total calcium, all the others were not significant. This shows that in the normal sheep at least, pH, total plasma proteins and magnesium have no effect on either ionized calcium *per se* or on the ratio of ionized to total calcium.

Although there is a highly significant correlation between ionized calcium and total calcium this is not of a sufficiently high order to enable prediction of the level of ionized calcium from the concentration of total calcium (see Figure). This lack of predictability, which has also been shown in man [2, 9, 15], demonstrates the necessity of ionized rather than total calcium determinations in the critical assessment of various metabolic disorders.

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EFFECTS OF STRESS ON THE RESULTS OF GLUCOSE TOLERANCE TESTS PERFORMED ON VERVET MONKEYS (*CERCOPITHECUS PYGERYTHRUS* F. CUVIER)

J. A. M. WHITE*, M. C. BOLSTRIDGE**, H. J. DOWNING**, B. C. WESSELS** AND H. J. KLOMFASS**

SUMMARY

Non-human primates are being used in large numbers for biological research and recent studies have shown the rôle of stress in causing disease among these animals. In this study involving vervet monkeys it was noticed that the results of glucose tolerance tests were significantly affected by the method of restraining the animals prior to the administration of the anaesthetic. These findings emphasize the importance of standardizing cage facilities and handling procedures in experiments with animals, especially where quantitative results are required for comparative studies on carbohydrate metabolism in higher primates.

INTRODUCTION

Non-human primates are being used in large numbers for biological research and two recent papers in this journal[1,2] have emphasized the rôle of stress in causing disease among these animals. Geldenhuys and his colleagues performed autopsies on baboons that had died of diarrhoea and found that 5,6 per cent had microscopic signs similar to those of ulcerative colitis in man. They also found adrenal cortex haemorrhages in 6,4 per cent and stomach ulcerations in 0,5 per cent. Furthermore these authors found parasitic infestations and bacterial diseases that could be attributed, at least in part, to the lowering of the animals' resistance by the stress and trauma of capture and adjustment to life in captivity. In the other study Price, Greef & Weber[2] performed autopsies on 160 baboons and found that the majority had suffered from adrenal haemorrhage and necrosis that could be attributed to stress. Not only is stress caused by housing and handling animals an important factor in causing disease, but it can also affect biological parameters during the course of an experiment. In a research program with vervet monkeys we noticed that the glucose tolerance tests were significantly affected by the method of restraining the animals prior to the admininstration of the anaesthetic.

MATERIALS AND METHODS

Animals and diet

The animals used were vervet monkeys (*Cercopithecus pygerythrus* F. Cuvier). They had been selected for an experiment on the basis of size, their average mass being 4 kg. Their diet had been standardized for a month and consisted of a daily ration of 100 g sweet potatoes, 35 g carrots, 35 g gem squash, 200 g wholemeal bread, one banana and one egg. Each animal had undergone veterinary examination before use in the project.

Anaesthetics

The monkeys were anaesthetized by intramuscular injection of ketamine † hydrorochloride at the rate of 15mg/kg body mass. Anaesthesia was maintained and muscular spasm counteracted by means of diazepam †† administered intravenously at the rate of 2,5 mg/kg body mass.

Glucose tolerance test

Glucose tolerance tests were performed on anaesthetized monkeys, after overnight fasting. Blood samples of 1 ml each were taken from the femoral vein by means of a polyethylene catheter inserted via the saphenous vein in the leg. After the first sample was taken 5 ml of a 40 per cent sterile, non-pyrogenic glucose solution was injected via the catheter. Further blood samples were taken at five minute intervals for the first thirty minutes and then at ten minute intervals for the next thirty minutes. These blood specimens were placed into tubes containing a few crystals of sodium fluoride; the plasma was separated and the glucose concentration determined on a Beckman Analyser using a glucose oxidase method.

*Addington Hospital, Durban.
**Natal Institute of Immunology, Durban.
Reprint Requests: Dr. H. J. Downing, Natal Institute of Immunology, P.O. Box 2356, Durban.
†'Ketalar', Parke-Davis Laboratories (Pty.) Ltd., Electron Ave., Isando, Transvaal.
††'Valium', Roche Products (Pty.) Ltd., P.O. Box 182, Isando, Transvaal.

Housing and restraint of monkeys

Seven of the animals were accommodated in individual metabolic cages that were equipped with metal grids which could be pulled forward to immobilize the monkeys for the administration of the anaesthetic. The other six monkeys were housed in larger cages and were restrained by means of a leather noose.

Statistical analysis of results

The blood glucose levels in the two groups were compared by means of the "t" test as in the formula.

$$t = \frac{Mean_1 - Mean_2}{\frac{Var_1}{N_1} \quad \frac{Var_2}{N_2}}$$

where Var is the variance or square of the standard deviation and N the number of monkeys in the group.

RESULTS

The blood glucose values have been expressed as mg glucose per 100 ml serum, and these, along with the statistical analyses, have been recorded in the table. The mean

Table: COMPARISON OF GLUCOSE TOLERANCE TESTS FOR STRESSED AND UNSTRESSED MONKEYS. SERUM GLUCOSE EXPRESSED AS mg/100ml

Time in minutes	SERUM GLUCOSE CONCENTRATIONS				't' Value
	Unstressed monkeys		Stressed monkeys		
	Mean	Variance	Mean	Variance	
0	91	399	164	840	5,21
5	287	1603	350	678	3,40
10	201	623	293	1368	5,10
15	186	574	276	2304	4,19
20	150	728	260	2118	5,12
25	137	728	250	2118	5,26
30	118	903	239	2706	5,04
40	96	840	215	1764	5,80
50	82	840	193	1092	6,34
60	67	679	182	576	17,39

pre-injection level of glucose for the monkeys caught with the noose, 164 mg/100 ml, was significantly higher than the mean for the monkeys in the metabolic cages, 91 mg/100 ml ($t=5,21$; $P< 0,05$). After the intravenous infusion of the glucose solution the blood glucose levels rose to a mean of 350 mg/100 ml for the monkeys caught with the noose and to 287 mg/100ml for the monkeys in the metabolic cages, the difference again being statistically significant ($t=3.4$; $P< 0,01$). Throughout the 60 minute test period the mean blood glucose levels of the monkeys caught with the noose were significantly higher than those of the other group ($P< 0,01$), while the mean clearance rates were 5,5 mg/ 100 ml/min and 4,34 mg/100 ml/min respectively. The mean time taken for the blood glucose levels to return to normal in the second group was 45 minutes while the glucose levels of the 'stressed' group did not return to normal during the test period.

DISCUSSION

The reason for studying the glucose tolerance test in monkeys was to determine the effect of various drugs upon the beta cells of the pancreas. In such a project it is not sufficient to restrict the tests to analyses of the urine and plasma, as in mild diabetes for example, as various compensatory adjustments may produce normal levels in a fasting animal. In these circumstances it becomes necessary to subject the carbohydrate metabolism to some selected stress in order to elicit a measurable abnormality. One such test is the intravenous glucose tolerance test and the present study has shown how the results of this test can be affected significantly by the method of handling the animal prior to the administration of the anaesthetic. Stress causes catechol amine release from the adrenals and a side effect of amine release is the mobilization of hepatic and muscle glycogen to produce elevated levels of blood glucose. In clinical states in primates this is characterized by β adrenergic stimulation for example, in cases of phaeochromocytomata (adrenaline secreting tumours) and primary thyrotoxicosis.

After the intravenous administration of a glucose solution the glucose level in the stressed monkeys rose to a higher level than in the unstressed animals and it remained significantly elevated under stress in the anaesthetized animal owing to a continuing amine release.

Consequently, the effect of stress on these monkeys would significantly effect any quantitative results obtained during the course of an experiment. These findings therefore emphasize the importance of standardizing cage facilities and handling procedures in experiments with animals, especially where quantitative results are required for comparative studies on carbohydrate metabolism in higher primates.

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NOTE AANTEKENING

TREATMENT OF TICK-INFESTED TORTOISES

JANE B. WALKER* AND J. D. BEZUIDENHOUT**

SUMMARY

The successful use of a carbaryl solution in the treatment of tortoises infested with *Amblyomma marmoreum* is described.

In late February, 1973 some information was requested on the means of controlling an alarmingly heavy tick infestation on pet tortoises in Pretoria. The owner said that, although he had kept these chelonians for many years, he had only seen occasional ticks on them in the past, which he had removed. He was advised to treat them with a solution of carbaryl as it was thought that this would be safest to use [1].

On the following day a visit was paid to the premises, a number of the tortoises was examined and ticks were collected. These were subsequently identified as larvae, nymphae and adults of *Amblyomma marmoreum* Koch, 1844. This is the commonest tortoise-tick in the Republic of South Africa, Lesotho and Swaziland; it has also been recorded in South West Africa, Botswana and the southern parts of Rhodesia and Mozambique [3]. Besides tortoises, its hosts include snakes, monitor lizards, very occasionally domestic animals and, in the immature stages, ground feeding birds [3].

The owner reported that he had treated all the tortoises by allowing them to paddle in a small bath filled to a depth of approximately 10 cm with a solution of carbaryl (Karbaspray 50, Agricura Kop Marketing Co.) mixed at the rate of 2 slightly heaped tablespoons per 4,5 *l* water. Some of the solution had also been poured in under the shell around the head, legs and tail of each tortoise, taking care to avoid its eyes and nostrils. Upon examination, it was seen that most of the ticks were dead. The tortoises were eating well and behaving normally, though sores caused by the ticks could be easily seen on some. They had apparently suffered no ill effects from the treatment. It was suggested that they should be treated again in a week to kill any remaining ticks and that a careful watch should be kept for possible future infestation.

Although it is capable of killing its hosts by exsanguination, *A. marmoreum* is not known to transmit any pathogens to them. Theiler [2] cites the death of a guinea fowl chick in the Austin Roberts Bird Sanctuary, Pretoria, caused by a massive infestation of larvae, and early in 1973 several tortoises died from heavy infestations of all stages of this tick in Windhoek, S.W.A. As in the Pretoria case, the owners stated that they had not encountered this problem before. The junior author treated some of the infested tortoises with sunflower oil applied with a brush with good results.

It would be interesting to know whether severe tick infestations have been seen on tortoises in any other areas during this year, and whether over the years the seasonal activities of this parasite have been noted by owners. As a single engorged *A. marmoreum* female can lay thousands of eggs her progeny could, under suitable conditions, quickly produce heavy infestations.

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*Veterinary Research Institute, Onderstepoort.
**Regional Veterinary Laboratory, Windhoek.

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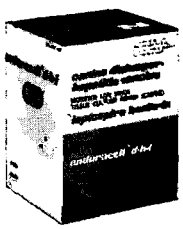

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ENZOOTIC CALCINOSIS OF SHEEP IN SOUTH AFRICA

R. C. TUSTIN*, C. H. PIENAAR**, J. M. SCHMIDT***, ADELE FAULT†, K. VAN DER WALT††, P.A. BOYAZOGLU††† AND H.P.A. DE BOOM‡

SUMMARY

An outbreak of a disease in sheep in the southern Orange Free State during the summer of 1966/67 is described. It bore a close resemblance to calcinosis in sheep described in Brazil, "enteque seco" of South America, "Naalehu disease" of Hawaii, "Manchester wasting disease" of Jamaica and "bovine enzootic calcinosis" of West Germany and Austria. The disease was manifested clinically by progressive stiffness of movement, emaciation and muscular weakness, palpable saphenous and femoral arteries, and after a prolonged course, death resulted from cardiac failure. The main lesion was a process of calcification which affected particularly the left atrioventricular and aortic valves, the endocardium of the left ventricle, elatic and muscular arteries of all sizes, arterioles, kidneys, lungs and focal areas beneath the parietal pleura. In some arteries the mineral deposits had stimulated intimal proliferation and, rarely, cartilaginous and osseous metaplasia.

The aetiology was not determined; as the majority of affected flocks had consumed excessive quantities of licks containing, *inter alia,* dicalcium phosphate, urea and maize meal during a period of severe drought, a conditioned magnesium deficiency might have been responsible for the development of heterotopic calcification. An attempt to reproduce the condition experimentally in sheep was not sucessful. The possibility of a calcinogenic factor in a plant being responsible—similar to the situation concerning *Solanum malacoxylon* and *Trisetum flavescens*—has not been excluded.

INTRODUCTION

During the summer of 1966/67 the appearance of a syndrome in sheep, characterized by stiffness of gait, progressive muscular weakness and loss of condition was brought to our attention. Histological examination revealed a widespread mineralization of various tissues and organs, particularly of the arterial system and kidneys. As this disease entity has hitherto not been reported in South Africa, a description thereof and of an attempt to reproduce it, form the basis of this report.

HISTORY

In the period mentioned, this disease was diagnosed and histologically confirmed on a total of 14 farms, all of them in the adjacent districts of Bethulie, Springfontein and Trompsburg in the southern Orange Free State, where the veld type is predominantly 'broken' (Afrikaans: 'gebroke'), i.e., a mixture of Karoo shrub and grass veld, and falls into the False Upper Karoo region according to the classification of veld types of South Africa by Acocks§.

A field investigation was undertaken during March 1967, and eight farms were visited. On five the disease had been diagnosed within the four months prior to our visit; on two of them its presence was unknown until detected during our inspection; on the remaining one, no cases had ever occurred, nor did any occur subsequently. Detailed histories were obtained from the farmers concerned, special emphasis being placed on climatic conditions, nutrition and on dosing and inoculation regimes during the preceding three years. Precise information was scarce: most of the farmers did not maintain detailed records, but relied on memory.

No definite epizootiological pattern was elicited by our inquiries. During the period in question the districts concerned had suffered severe drought. The weather had ameliorated however, and good summer rains had fallen two to three months before our visit: the veld vegetation had recovered and was in a reasonable condition. On six of the seven affected farms the disease had apparently made its first appearance immedia-

*Division of Toxicology, National Research Institute for Nutritional Diseases, S.A. Medical Research Council, P.O. Box 70, Tiervlei, Cape Province; formerly of the Section of Pathology, Veterinary Research Institute, Onderstepoort. Present address: P.O. Box 12580, Onderstepoort.
**Private Practitioner, P.O. Box 428, Bloemfontein; formerly State Veterinarian, Bloemfontein.
***Private Practitioner, Springbokfontein, Bethuli.
†State Veterinarian, P.O. Box 502, Bloemfontein.
††Department of Medicine, Faculty of Veterinary Science of the University of Pretoria, Onderstepoort.
‡Department of Anatomy, Faculty of Veterinary Science of the University of Pretoria, Onderstepoort.
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tely before or after the first summer rains had fallen, while on the seventh farm cases had been seen by the farmer 8 to 9 months previously. It was concluded that in some way the drought and occurrence of the disease were linked.

The predominant breed of sheep in this area is the Merino and most of the affected sheep were of this breed; in rare cases affected Merino crosses were encountered. Exact figures regarding rates of morbidity and mortality and of sex and age incidence were not available. We estimated that on some farms the morbidity was as high as 15 to 20 per cent. Adult ewes were mostly affected, wethers and young sheep less so. Young lambs were free from the disease. On some farms the disease occurred principally in animals in one particular camp. This may have influenced the sex and age incidence. Of two farmers who both own two farms situated relatively closely to each other, one reported that he had had cases in one camp on one farm only, while the other had encountered the disease on both of his farms, but only in one particular camp on each. One affected flock had grazed in the one camp concerned for about 12 month, and the other in its particular camp for 2 months. The treatment meted out to all the sheep in the flocks belonging to these two farmers was similar. While no detailed botanical surveys of the vegetation in the various camps on the affected farms had been undertaken, no major differences in plant species were apparent between the camps which had contained affected animals and those in which no overt cases had occurred. This particular aspect warrants further investigation.

The farmer who had suffered the most severe losses had noticed the first cases during November 1966, soon after a few showers of rain had broken the drought. At the time of our investigation *in loco,* 80 sheep had died and 40 affected animals were being kept isolated. New cases were still occurring. On the other hand, on another farm which we visited by chance, the farmer was unaware of the disease until we found five or six Merino ewes in a flock of 400 in poor condition, as well as several wethers in another flock. Clinical examination of some of these animals and necropsies on two ewes and one wether established the occurrence of calcinosis. According to the farmer, it had been a long time since a sheep had died on his property: the disease obviously was more widely distributed than we, or even the farmers, were then aware.

The owners of the farms visited had practised a variety of forms of supplementary feeding during the drought. Three of them had dosed their sheep with fish liver oil during the 15 months preceding our investigation. Only one had used it with any degree of regularity: he had dosed his sheep half the recommended amount at 6 weekly intervals during the preceding winter, and had been doing this for a number of years. Of the other two farmers, one had administered the oil to his sheep once during the winter and the other once during the early summer, after the first deaths had occurred.

At various periods during the drought, the sheep on all eight farms had been fed whole maize and/or proprietary brands of sheep pellets, but not with any degree of regularity. The quantity of so-called 'lick' fed to and consumed by the sheep during the drought on all eight farms was most striking. The composition of these licks varied from farm to farm and from time to time; unfortunately not all the farmers were able to supply us with the precise amounts of the various constituents they had used in the preparation of the licks which they had mixed themselves, nor was it possible in every case to estimate the daily amounts actually ingested by the sheep. In table 1 an indication of the various constituents of the licks is given. On some farms the lick was made freely available to the sheep, while on others it was dispensed twice a week. It was noteworthy that the sheep were ingesting large amounts of lick on most of the farms, apparently in an attempt to satisfy their energy requirements and, in some cases, also their nitrogen requirements, which were deficient because of the drought, rather than their mineral needs. In this respect, the conditions prevailing at the time on Farm 3 (table 1) may be used as an example. Here there was a total number of 884 sheep, comprising 400 adult ewes, 200 maiden ewes and 284 young wethers and rams. The owner considered that 125 adult ewes were showing signs of the disease. Excluding the rams, the amounts of lick fed to the sheep were 6 oz. for the adult ewes and 3 oz. for the others per day. These amounts were made available to the sheep twice a week: about 20 oz. per ewe twice a week. As the drought worsened, the sheep consumed their twice-a-week ration in one day. According to our calculation they were ingesting the equivalent of 1,74 g calcium on two days a week exclusively from

Table 1: CONSTITUENTS OF 'LICKS' USED ON THE EIGHT FARMS

CONSTITUENT	FARM							
	1	2	3*	4	5	6**	7	8
Dicalcium phosphate	+	+	30 lbs. +	+	+	+		+
Sodium chloride	+	+	50 lbs. +	+	+	+	+	+
Maize meal	+	+	180 lbs. +	+		+	+	+
Flowers of sulphur	+		3 lbs. +			+		+
Urea			15 lbs. +	+				
Molasses			+	+				
Proprietary preparation***							+	+

*The actual quantities of the constituents comprising the lick used on this farm are given as an example. A solution of molasses and water was added after the other components had been mixed together.

**No cases of the disease occurred on this farm.

***This preparation comprises chiefly molasses containing several trace elements.

the lick, let alone that from other sources. Once the rains had started and the veld vegetation had improved, they had lost interest in the lick and had ingested very little of it.

The sheep on the various farms had also been subjected periodically to treatment with a variety of anthelmintics, the majority of which is used universally throughout South Africa. Water from five boreholes on two of the farms was analysed but we could not ascribe an aetiological rôle to its mineral content.

After our visit to the districts concerned in March 1967, the number of new cases gradually diminished. Several isolated cases, however, have subsequently been encountered periodically by one of us (J.M.S.) who practises in the area where the outbreak occurred.

CLINICAL SIGNS

The information obtained from the owners and clinical examination of some of the affected sheep allowed the following clinical picture to be drawn.

Signs of the disease are first noticed when an animal stands after being recumbent. Its back is flexed, the first few steps are short, and initially it walks stiffly. The stiffness soon wears off and thereafter no abnormalities in the gait can be noticed. Nevertheless, the animal is inclined to lie down and rest more frequently than is usual, and it gradually loses condition over a period of weeks or months. The stiffness in many cases becomes progressively more pronounced and the animal weaker and weaker. Some affected sheep may even graze on their knees. Animals suffering from the condition can be picked out with relative ease by farmers: of eight sheep submitted by them to the Veterinary Research Institute, Onderstepoort, all proved to be typical cases. On the other hand, as mentioned above, at least one farmer was unaware of the presence of the disease in his sheep until we demonstrated it to him. In severely affected animals the saphenous artery may be felt as a thin rigid cord beneath the skin and a pulse may not be present in it. The femoral artery may be similarly affected. Diagnosis may be assisted by X-ray examination of the neck, as in some cases the calcified carotid arteries are easily visible.

No fever occurs, nor is there any outward manifestation of lesions affecting the locomotor system which might be held responsible for the progressive stiffness. The appetite remains unimpaired.

The disease is of long duration and extends over a period of weeks or months. On the whole, relatively few deaths occur. It appears that the majority of clinically affected animals slowly improves after a change in the peculiar set of environmental conditions which are presumed to play a contributory rôle in the aetiology. When death does occur,

the cause is usually cardiac insufficiency with dilatation of the heart and transudation into body cavities. One of the cases examined was unable to stand: its abdomen was greatly distended due to ascites; another, autopsied by one of us (C.H.P.), and which first drew our attention to the disease, died suddenly from internal haemorrhage following rupture of an aneurism in the cranial mesenteric artery. An affected animal was sent to Onderstepoort and kept there for 18 months before it died; although the cause of its death could not be determined with any degree of certainty, mineralization of the arteries and of several organs and tissues was still prominent.

PATHOLOGY

During the investigation 21 affected sheep were autopsied. Five of these animals had died spontaneously, while the remainder, which were in various stages of the disease—from mild to severe—were slaughtered. The following account is a synopsis of the lesions seen in these animals.

Macroscopic pathology

The animals are in poor condition and some even cachectic. Those which die spontaneously invariably have a generalized venous congestion with petechial haemorrhages present in or beneath the serous membranes, particularly those of the epicardium, and sometimes of the endocardium. Varying amounts of transudation are present in the body cavities. In one case, mentioned above, the amount of ascitic fluid was so voluminous, that the abdomen was greatly distended by it. Furthermore, *post-mortem* examination of this animal revealed the presence of approximately 300 ml of transudate in the thoracic cavity, as well as hydropericardium. In another advanced case 200 ml transudate was present in the peritoneal, 500 ml in the thoracic and 20 ml in the pericardial cavities. Haemopericardium was encountered in one slaughtered animal, the heart sac being distended by a large volume of fresh, unclotted blood which had originated from the rupture of a small, superficial branch of a coronary artery. The haemorrhage probably had occurred at the time of slaughter as the result of increased blood pressure owing to the unaccustomed handling. Haemoperitoneum and haemopericardium, however, are exceptional.

Pulmonary oedema, from mild to marked, occurs frequently. Emphysema of the *lungs* is noted in some cases. In most of the examined animals which had this lesion, it was presumed to be secondary to the method of slaughter, as only in a small number of the sheep was calcification of the alveolar walls of the lungs with an associated emphysema seen microscopically. Pulmonary mineralization not seen macroscopically.

The most characteristic lesion of the disease, seen in all the sheep, is mineralization of various organs and tissues of the body. Most commonly and intensely affected is the wall of vessels of the *arterial system*. The lesion in this tissue varies in extent: in sheep, clinically judged as early cases, it generally has a focal distribution, irregular lengths of the vessel being involved and the aorta particularly being affected. In advanced cases, the walls of virtually all the major arteries and their branches that can be dissected macroscopically are involved. A notable exception to this, however, is the pulmonary artery; in not one of the animals autopsied was the wall of this particular vessel involved.

The degree of mineralization of the abdominal as compared to the thoracic aorta varies. It frequently is more severe in the abdominal than in the thoracic component of this vessel; it may be the same, or the reverse situation may obtain. The mineral salt is not always evenly deposited in the walls of vessels manifesting the change: in the more severely involved parts, the deposits are plaque-like and of irregular size and shape, while in other parts they are more uniform and diffuse. Where the calcification is advanced, the vessel is dilated and its wall thinner than normal, dull white in colour and of parchment-like appearance. (The aorta of one case actually crackled when handled after fixation in formalin.) The internal diameter of the carotid arteries of some cases approximates that of the jugular veins. The elasticity and thereby the function of affected vessels are thus greatly impaired. The veins of the body are not affected by this process of mineralization.

The *heart* in many of the animals is enlarged, primarily as a result of a dilatation of the chambers on the left side. In some, however, all four chambers are dilated. Dull white areas of mineral deposit, varying in extent and degree, occur in the tissues of the heart, particularly in the left atrioventricular valves and in the endocardium at the bases of these and the aortic valves. Calcification at these sites is present even in some of the animals slaughtered at what is judged to be an early stage of the disease. In some sheep the mineral salt is also deposit-

ed in foci of varying sizes in the epi- and endocardium, and at the origin of the chordae tendineae. The tissues of the left cardiac chambers are more frequently affected in this pathological process than are those of the right. Macroscopically the myocardium does not appear to be calcified, although in two of the animals, fresh infarcts were present in the heart muscle, in addition to a focal scar in the myocardium of one of them; this was assumed to be a healed infarct.

Small foci of mineralization beneath the *pleura* of the thoracic wall and in the tendinous part of the diaphragm are rare. On the other hand, macroscopic evidence of the deposition of mineral salts in the *kidneys* was seen in the majority, but by no means all, of the cadavers examined. The renal cortex is particularly involved in this process; in some of the animals it appears to be an early phenomenon; in some severely affected cases its focal dissemination produces a speckled appearance. In one animal two recent and one healed renal infarcts were encountered. Lesions adjudged to be those of cyanotic induration were noticed in the *livers* of two sheep.

That the mineral probably remained for some length of time at the site of deposition, was manifested by the one case which was removed from the farm and kept at Onderstepoort until death 18 months later. Typical macroscopic and microscopic lesions were observed.

Histopathology

In general, the changes seen macroscopically were confirmed histologically, and therefore only those of special interest or those not seen during the *post-mortem* examinations will be mentioned. As is to be expected, the histopathology is dominated by the focal and generalized mineralization of many tissues, those of the heart and arteries particularly being affected. The mineral stains positively by both the alizarin and Von Kossa's methods, and is therefore assumed to consist principally of calcium phosphate.

In all the animals the greatest deposition of the calcium salt occurs in the walls of the *arteries* (Figs. 1—4, 6). This change affects these vessels in the majority of tissues and organs in severely affected cases. Elastic and muscular arteries and arterioles are equally involved. In most instances the mineral appears to be deposited initially in the elastica interna, at first in granular form, and thereafter more densely. No definite pattern of distribution follows this initial phase. It may remain confined to the elastica interna, or the tunica media may contain the heaviest deposits. The affected elastica interna becomes thickened and loses some of its wavy outline in section, thus appearing straighter. It is frequently split irregularly into two or more fibres or is fragmented. When severe, the deposition of the mineral is associated with a destruction and disappearance of the normal underlying elements. In some vessels it appears focal and plaque-like, but in others it affects the entire width and circumference, excluding in most cases the tunica adventitia. In more mildly affected cases the calcium phosphate appears to be deposited particularly in the elastic laminae of the aorta, and in most sheep the lesion is most frequently encountered in the tunica intima and innermost half or two-thirds of the media of this vessel (Fig. 1). At most sites the calcium deposition in the arterial walls seems to provoke very little cell reaction, although focal areas of smooth muscle cell and undifferentiated cell proliferation occur in addition to a focal leukocyte infiltration (Fig. 3). Some of these areas in the aorta infrequently are associated with deposition of an amorphous, fibrillar, cartilaginous or osseous ground substance and, rarely, in some large arteries, with invasion of capillaries into the media.

In many arteries, heavy mineral deposits, particularly when focal, cause a protuberance of the intima into the lumen. In some vessels, especially in the branches of the coronary arteries, proliferation of subendothelial elements in the intima had occurred, in places extensively so (Figs. 3 and 4). In most cases, but by no means in all, this change is associated with calcification of the elastica interna or media in the same histological section.

The pulmonary arteries and the veins of the body apparently are exempt from the process of mineralization.

In addition to the macroscopically visible sites of mineralization in the *heart*, a focal calcification of myocardial fibres is observed in several cases. This lesion is at times associated with degenerative change and some fibroplasia. It is assumed that these changes, and the myocardial infarction seen in two of the animals, are secondary to the arterial pathology. Calcification of the cartilage of the skeleton of the heart is also seen; in one case there was evidence of early ossification.

The main change seen to some extent in the *kidneys* of all animals examined, is calcification of arterial walls and parenchyma.

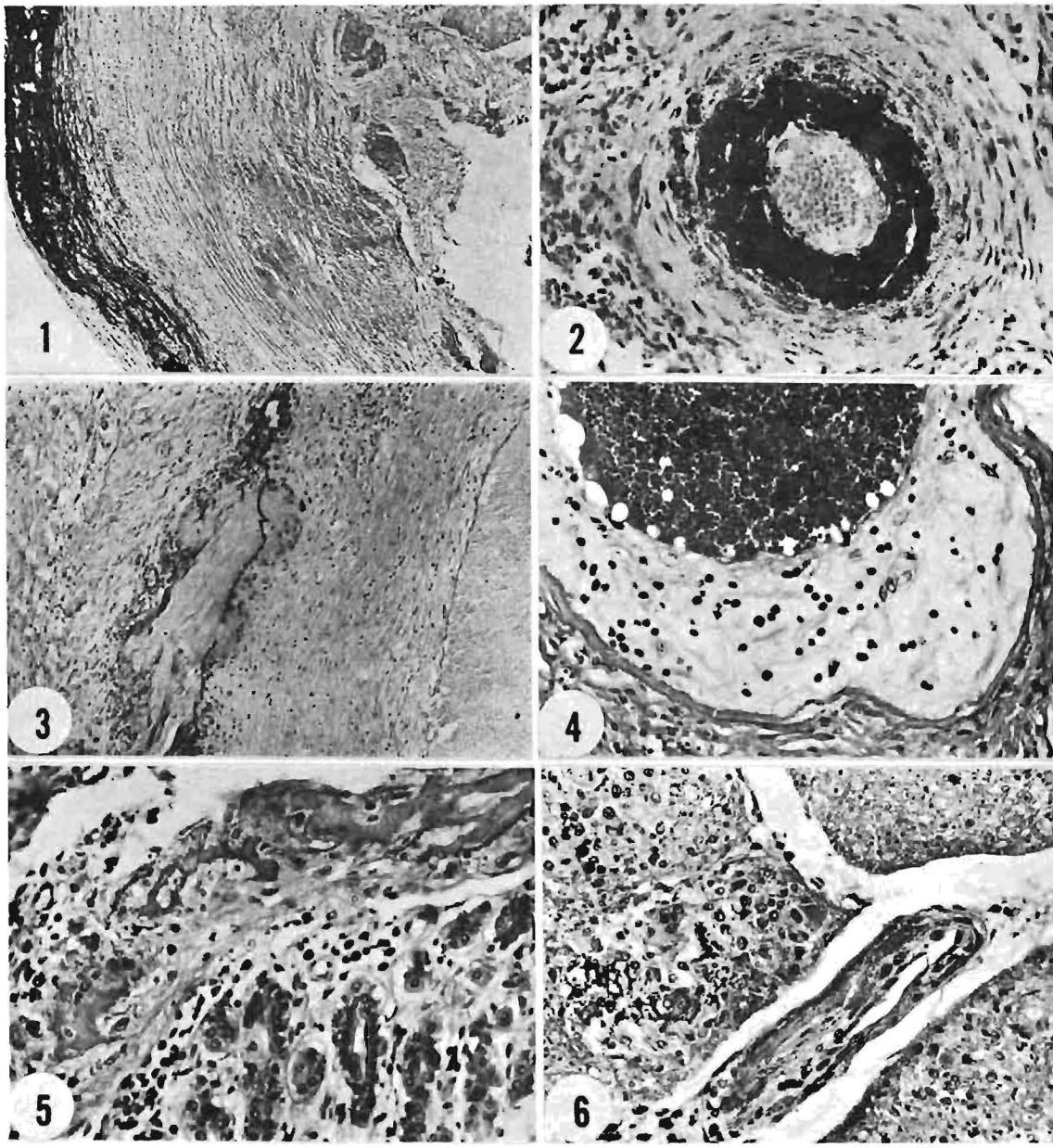

Fig. 1: Calcification of the inner third of thetunica media of the aorta. Von Kossa. ×250.

Fig. 2. Media calcification of a muscular artery in the uterus. Von Kossa. ×400.

Fig. 3. Subendothelial proliferation of the tunica intima of a branch of the coronary artery and the focal deposition of calcium (homogenous, lightly staining area) which has evoked a mild tissue reaction together with some duplication and irregularity of the elastica interna. Verhoeff's elastic stain. ×160.

Fig. 4: Subendothelial proliferation and calcification of the elastica interna in the intima of a small artery in the submucosa of the abomasum. H and E. ×400.

Fig. 5: Calcification of the muscularis mucosae of the abomasum. H and E. ×400.

Fig. 6: Focal degeneration and calcification of the smooth muscle in the wall of the rumen and partial mineralization of an adjacent small artery. H and E. ×400.

The vascular lesion affects vessels, of all sizes, from the renal artery itself to afferent and efferent arterioles. The mineral is deposited focally in the parenchyma and, in contrast to our macroscopic observations, occurs particularly in the outer zone of the medulla, although the cortex and rest of the medulla are not exempt. It is present within epithelial cells, in the interstitial tissue and in the lumen. Rarely the basement membrane of the parietal layer of Bowman's capsule is the site of deposition.

A focal emphysema of the *lung* is present in several cases. In several sheep this change is associated with a calcification and thickening of the alveolar septa, and with a mild round cell reaction, more rarely with the presence of multinucleate cells and epithelialization of some alveoli. Partial calcification of some bronchial cartilage rings and musculature is also present; the change in the latter tissue frequently is associated with degeneration and cellular proliferation, although the focal degeneration also occurs in places independent of mineral deposition. Mineralization of the bronchial mucosa is a rare finding. Mild focal calcification of the *tracheal rings* is present in some cases.

In some sheep a focal degeneration and cellular hyperplasia of the musculature of the wall of the *rumen* is noticed (Fig. 6), frequently accompanied by the deposition of calcium. Short lengths of the *muscularis mucosae* of the *abomasum* are calcified (Fig. 5), as are small areas of the connective tissue of the mucosa and submucosa. Focal areas of calcification and fibroblastic activity are encountered in the tendinous part of the *diaphragm*.

The parenchyma and supportive elements of the *spleen* and *liver* are not involved in the mineralization process. Furthermore, none of the vessels within these organs, nor those of the *brain* and meninges are affected.

The *parathyroid glands* of four sheep were examined: none was hypertrophic.

BIOCHEMICAL ANALYSES

Samples of the liver and aorta from several of the affected animals which were autopsied and from control sheep originating from without the districts concerned were analysed for copper, magnesium, manganese and/or calcium with the following results:

1. The liver copper content of six animals suffering from the disease averaged 186 parts per million (dry basis) and ranged from 60 to 287. This is somewhat below the average of 240 ppm obtained in 'normal' sheep, but it does not denote a deficiency.
2. The average liver magnesium content for six affected sheep was 214 ppm (dry basis; range 195 to 232), which is well below the average of 410 ppm obtained in control sheep.
3. The liver manganese analyses proved to be exceptionally low with concentrations of less than 3 ppm (wet basis) in those cases of the disease in which it was determined. The average figure for the unaffected control animals was more than double this value.
4. Analyses of the calcium content of the aortas from five diseased sheep yielded an average figure of 407 ppm (dry basis; range 372 to 434). That of the unaffected control sheep was 243 ppm.
5. The magnesium content of aortas averaged 122 ppm (dry basis; range 110 to 140) for five affected animals and 306 ppm for the controls.

These results indicated that the diseased sheep were possibly suffering from manganese and magnesium deficiences. As a deficiency of magnesium is known to result in soft tissue calcification in various animal species, and because earlier surveys of the mineral constituents of the natural pastures in the southern Orange Free State and adjoining north-eastern Cape Province had indicated magnesium deficiency [15], the experiment described below was devised in order to determine whether an induced deficiency of this mineral in sheep would, in fact, lead to the development of lesions identical to those which we had encountered in the disease under review.

EXPERIMENTAL WORK

Materials and Methods

Forty-eight one year-old Merino wethers were purchased from a farmer in the Barkley East area. Soon after arrival at the Veterinary Research Institute, Onderstepoort, they were divided at random into four groups, each containing an equal number of animals. During the experiment all the animals received distilled water for drinking purposes and teff hay which was selected because of its low magnesium content. Two large batches of this hay from different areas were specifically purchased; the first contained 0,09% magnesium and 0,20% calcium by weight and was fed for the first 262 days, while the second contained 0,13% and 0,11% respectively, and was fed during the remaining 451 days of the experiment. In addition, the animals received a lick, the composition of which varied according to the group as shown in table 2.

The hay, lick and water were freely avail-

Table 2: CONSTITUENTS OF THE LICKS FED **AD LIBITUM** TO SHEEP IN THE FOUR GROUPS

Lick*	Group 1	Group 2	Group 3	Group 4
Urea	15	15	15	15
Maize samp**	65	50	60	45
Sodium chloride	20	20	20	20
Dicalcium phosphate	0	15	0	15
Magnesium carbonate	0	0	5	5

*Constituents given as a percentage by mass.

**Maize kernel from which the germ has been removed.

able to the animals at all times. With the exception of one sheep from Group 2, which died 103 days after the commencement of the experiment from complications resulting from a ruptured oesophageal diverticulum, half the number of animals in each group was slaughtered and autopsied on Day 313 and the remainder on Day 713. Specimens of the liver, kidney, lung, heart, aorta and carotid artery were taken for histological examination. Sections were cut after formalin fixation and were stained by haematoxylin and eosin, by the alizarin method for calcium and Von Kossa's method for phosphate. The aorta from each animal was tightly rolled, cranially to caudally, after it had been incised longitudinally for macroscopic examination of the intima, and was so secured before fixation. Lengths of carotid artery were similarly treated. This rolled position of the arteries was retained during the embedding and sectioning processes: histological examination thus included viewing virtually a section of the entire length of the aorta.

Results

In table 3 is shown the quantity of the licks and hay consumed and the body mass of the sheep during the course of the experiment. The pattern and amount of body mass loss were more or less similar in the animals in all four groups. It is evident that the rations fed were merely able to sustain life after the initial mass loss, as well as some wool growth, which was not measured. The sheep in the group receiving the highest quantity of maize samp in the lick consumed the most, although this does not appear to have exerted much influence on their live mass. The two groups of animals receiving the licks containing dicalcium phosphate daily, ingested relatively large amounts of this substance. If the hay is excluded as a source of calcium, then the sheep in Group 2 ingested 3,4 g Ca and those in Group 4 3,8 g a day. These amounts are in excess of those calculated as being fed to the sheep on at least one of the farms mentioned above.

Macroscopical lesions resembling those seen in the field cases were only noticed in one sheep in Group 4 (tables 2 and 3), which was autopsied on Day 713. These consisted of scattered, greyish-white foci and plaques of mineralization of the aorta, the abdominal part of which was more severely affected than the thoracic. Additional organ and tissue specimens for histological examination were taken from this case. No evidence of the disease was found in any of the other animals.

On histological examination of the tissues from the animals slaughtered on Day 313, rather rare foci of an amorphous basophilic substance (stained with haematoxylin and eosin) were observed in the interstitial tissue of the inner zone of the medulla of the kidneys in two sheep, each in Groups 1 and 2, four sheep in Group 3 and five sheep in Group 4. This substance did not stain by either the Von Kossa or the alizarin method and its nature remains uncertain. A similar substance was found in the kidneys of all the sheep slaughtered on Day 713. The foci in the latter sheep, however, were more

Table 3: QUANTITY OF LICK AND HAY CONSUMED AND BODY MASS OF THE SHEEP

	Group 1	Group 2	Group 3	Group 4
Total quantity hay ingested (kg)	4 895	5 058	4 898	4 947
Hay/sheep/day (g)	795	850	795	803
Total lick ingested (kg)	897	533	629	624
Lick/sheep/day (g)	145,8	89,8	102,1	101,3
Average mass of sheep (kg):				
1. At commencement	44,27	44,24	44,24	44,27
2. Those slaughtered on Day 313	33,41	37,09	32,67	33,18
3. Those slaughtered on Day 713	33,68	32,47	31,51	30,36

numerous and generally more basophilic, some being strongly so. In addition, some, but not all, stained positively by the Von Kossa and alizarin methods. The presence of this substance may well have been related to the diet as it appeared more often and in greater amounts in animals that had been in the experiment longest. Age may also have played a rôle. Some evidence of it was also seen in the kidneys of the sheep which died on Day 103 of the experiment. The location of most foci containing this substance in the kidney was somewhat different from the deposits of mineral seen in this organ in the natural disease.

Apart from these renal changes, no other lesions of note were observed in any of the animals, with the exception of the sheep in group 4 mentioned above. The pathological changes in the aorta of this animal very closely resembled those seen in some of the field cases; they consisted of plaques of mineralization of the media. These were located primarily at approximately the site of junction of the inner and middle thirds of the wall of this vessel. Again, very little tissue reaction was evoked by the presence of this material, which stained positively by both the alizarin and Von Kossa's methods. In addition to these aortic lesions, histological examination of both the left and right carotid arteries revealed very small scattered foci of proliferation of what appeared to be an undifferentiated cell type in the media of the inner third of the vessel wall. The smallest of these consisted of two to three cells, while the largest contained no more than ten. Some were associated with the deposition of a small quantity of an amorphous, somewhat granular, eosinophilic material, and in their vicinity the elastic laminae were discontinuous and stained more basophilically than normal. The elastica interna of the intima in parts appeared thicker, irregular and/or duplicated. Here and there it was discontinuous. The elastica interna of the coronary artery had a stippled, rather granular appearance, owing to very small parts of it being more basophilic than usual. No calcium deposition was present, however, as a negative reaction was obtained with the alizarin stain. No other noteworthy lesions were observed in other arteries or tissues of this case.

The changes observed in the carotid and coronary arteries were interpreted as being degenerative and it is possible that they preceded those of calcification. As only one experimental case did develop lesions resembling those of the natural disease to some extent, no definite conclusion can be drawn as to its significance. Notwithstanding, it is interesting to note that this animal was in one of the groups receiving both dicalcium phosphate and magnesium carbonate in the lick. If it is assumed that the lesions were due to a mineral imbalance, then the magnesium carbonate did not afford it any protection.

DISCUSSION

For want of a better name for this particular disease, which is obviously a form of heterotopic calcification, the term 'ovine enzootic calcinosis' is proposed. We suggest that it should be used until the aetiology has been determined unequivocally. A more specific apellation may then be advisable in order not to confuse it with other conditions presenting similar pathological pictures, but which are perhaps of different aetiology. The disease in sheep occurring in enzootic form on several farms in the highlands of the state of Rio Grande do Sul in Brazil [5] very closely resembles the disease we have described, both clinically and pathologically. The condition in Brazil was first recognized on three farms in 1968, and appeared to occur seasonally during the summer and autumn. As many as 5 to 10% of a flock could be affected, the course lasting 2 to 3 months. According to Barros, Tokarnia & Döbereiner [6], it recurred on one of the farms during the summer of 1971/72, when it was also diagnosed for the first time on another. The aetiology has not been determined. Although it is the practice of the majority of the farmers in the region concerned to make licks containing salt and bone meal available to their livestock, the disease does not appear to be related to the feeding of licks, nor to drought conditions [6].

Interestingly, another disease with similar symptomatology and pathology occurs in cattle in the state of Mato Grosso in Brazil. Colloquially, it is known as *espichamento* or *espichaçao** and is characterized by calcification in various organs, mainly in the lungs (where it is also associated with ossification and emphysema), endocardium, aorta and

*The substantive Brazilian words **espichamento** and **espichação** are derived from the verb **espichar** which has a variety of meanings: "to stretch out", "to stick out" (e.g. the neck), "to stretch" (e.g. hides), "to stretch out and die", "to flop", "to fall down", or "to fail". It is not now known precisely which of these was originally used when referring to the disease[24].

other major arteries, renal medulla and tendons. It has been shown to result from the ingestion of the plant, *Solanum malacoxylon*[13], the toxic effect of which apparently increases calcium absorption from the diet[23]. This disease is identical with a wasting disease of grazing animals named *enteque seco* (dry emaciation) which is frequently encountered in the province of Buenos Aires in the Argentine. It is most often seen in cattle because these are the most common animals in affected areas. Sheep and horses are not often found with the disease, but lesions have been found at necropsy in both species. It was shown to be related to the ingestion of *S. malacoxylon* in 1967[29].

That sheep are experimentally susceptible to the toxic effects of *S. malacoxylon* was shown by Camberos & Davis[8], who demonstrated that increased absorption of calcium and phosphorus occurred in animals fed the plant. Calcification of the cardiovascular system was observed in fatal cases. Experimentally produced lesions following the daily administration of aqueous extracts of the plant to sheep have also been studied[16]. The specific form of calcinosis occurring in sheep in Brazil, as described by Barros, Pohlenz & Santiago[5], however, is definitely not related to the ingestion of *S. malacoxylon*, as this plant and the disease do not occur in the same region[6].

Other conditions, affecting primarily cattle and characterized by the development of lesions similar to those seen in *enteque seco*, are Naalehu disease of Hawaii[20], Manchester wasting disease of Jamaica[4] and forms of calcinosis in Germany and Austria[9, 10, 12, 18]. Lynd[20] assumed the cause of Naalehu disease to be a mineral imbalance consisting of a deficiency in phosphorus and magnesium when there is a simultaneous high intake of potassium and calcium by animals; an imbalance of calcium, magnesium, phosphorus and vitamin D has been suspected to play a rôle in the aetiology of the Jamaican disease[3, 4]. Concerning the aetiology of the disease occurring in Germany, Dirksen, Plank, Hänichan & Spies[11], have recently discovered that a species of grass, *Trisetum flavescens*, collected from 'calcinosis farms', contains a calcinogenic factor: it causes the deposition of calcium salts in the arterial system when fed to rabbits.

There is no doubt that ovine enzootic calcinosis in South Africa resembles the diseases mentioned above very closely. The aetiology, however, remains enigmatical. Shortly after the first case of ovine calcinosis was diagnosed in this country, it was thought that the accidental, excessive or perhaps even the over-exuberant administration of vitamin preparations containing vitamin D would probably be proved to play a rôle. This theory was soon quashed on closer investigation of the outbreak. Another hypothesis regarding the cause was that a mineral imbalance was possibly implicated. This arose from the discoveries that the magnesium content of the livers and aortas of affected animals was below normal and that sheep on farms on which the disease occurred, had consumed inordinately large quantities of 'lick'. The majority of the latter contained dicalcium phosphate, sodium chloride and maize meal in varying proportions and some, in addition, contained other constituents, including urea. It was surmized that the severe drought which had prevailed for three years before the disease was first diagnosed, was responsible for this greatly increased intake: the animals no doubt had relied on the licks as a source of energy, for which purpose they were naturally not primarily intended. Notwithstanding, the demand by the sheep for increased quantities of lick was met by many of the farmers. The complexity of interrelationships, which in some cases may be antagonistic, not only between minerals themselves in the diet, but also between minerals and other nutrients, such as vitamins and proteins, is well known[2, 27], and it was considered that the increased ingestion, particularly of calcium, phosphorus and nitrogen possibly was interfering with magnesium absorption and/or utilization, and that this was responsible for the calcification of various tissues of the body.

The development of nephrocalcinosis in rats reared on diets low in magnesium, was first reported in 1936[17, 25] and has since been studied extensively. Calcification of the myocardium, skeletal musculature and liver has also been observed in rats which are deficient in magnesium[1, 17, 19]. Calcification of the elastica interna and media of the aorta, of the coronary and peripheral vessels and of the inner portion of the myocardium has been seen in puppies when given a magnesium deficient diet[26]. Calcium deposition in the kidneys of these animals was virtually absent. Deprivation of the element from calves may also produce calcification of various tissues such as the endocardium, aorta, other large

arteries, kidneys, muscles, spleen and diaphragm[7, 14, 21]. The induction of a magnesium deficiency in sheep in order to study the subsequent pathology was therefore attempted as outlined above. Inconclusive results were obtained in this experiment, and the question as to whether or not a deficiency of this element did, in fact, play a rôle in the development of the natural disease, has yet to be answered. Most of the farmers concerned reported that once the drought had been broken the sheep only consumed very small quantities of the licks. This appeared to go hand-in-hand with a decreasing incidence of the disease. It is interesting to note that rather frequently foci of calcification of unknown cause are encountered incidentally in the renal medulla of South African sheep. Focal calcification of the aorta, however, is only very rarely seen. A genetic variation in mineral metabolism between individuals and breeds of sheep has also been reported[22].

Another possible cause which was considered but not investigated in depth because the improved climatological conditions had greatly changed the nature of the veld at the time of our visit, was that a toxic plant species, not eaten under normal conditions, had been ingested by the sheep during the drought, or shortly after it was broken. This likelihood is strengthened not only by the apparent occurrence of the disease in only one camp on many of the farms, but also by its appearance late in the course of the drought. Furthermore, the decreased incidence of the disease once environmental conditions had ameliorated, also lends support to this hypothesis. It was only after the cessation of the outbreak that reports of the experimental reproduction of *enteque seco* by the feeding of *S. malacoxylon* reached us. This particular *Solanum* species does not occur in South Africa, although many other species do: at least 12 of them are known to occur in the southern Orange Free State[23]. Two cases of experimental chronic *S. malacoxylon* poisoning in sheep have been produced in South Africa in order to compare the resultant pathology with that seen in the natural South African form of ovine calcinosis. From the comparison it appears that these two diseases, although very similar, are not identical. Categorical statements in this respect, however, cannot be made at this preliminary stage.

The recent finding in Germany that the grass, *T. flavescens*, produces arterial calcification when fed to rabbits, is also of significance although the toxic principle has not yet been identified. It brings the number of plant species containing calcinogenic factors to two. This may well increase the possibility that other plant species may exist which also contain substances with a similar action when ingested by animals. One of these may possibly occur in the southern Orange Free State or even have a wider distribution. It warrants further investigation, particularly as isolated cases do continue to occur in the Orange Free State. The genus *Trisetum* is not represented in South Africa[28].

Other known causes of heterotopic calcification include primary and secondary hyperparathyroidism. Neither of these was implicated in the disease investigated.

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BOOK REVIEW BOEKRESENSIE

W.H.O. EXPERT COMMITTEE ON RABIES SIXTH REPORT

W.H.O. Technical Report Series No. 523, 1973

The issuing of the sixth report of the W.H.O. Expert Committee on rabies is an important milestone in the continuing struggle against this disease. For those involved, or even only interested, it is a valuable booklet summarizing all aspects of our current knowledge of epizootology, control, prevention and treatment. Each ensuing report is longer and more detailed than its predecessor, reflecting the painstaking process of accumulating new and important data all of which are evaluated and interpreted by the committee.

It is almost eighty years since Louis Pasteur first produced his celebrated vaccine and in truth improvement of rabies vaccine for human use in this period has been slow, far slower than in the veterinary field. Now modern technology has conquered the major obstacle of demyelinizing encephamolyelitis by introducing tissue culture vaccines free of foreign nervous tissue. This inactivated virus vaccine produced in human diploid cells (strain Wi 38) has the antigenicity lacking in duck-embryo vaccine (DEV) and will, I predict, become the standard for both pre- and post-exposure vaccination.

The importance of this development cannot be over-estimated. In South Africa alone several hundred people are exposed to rabies annually and must endure the Pasteur type treatment of 14 daily injections plus the hazards of potential serious side effects. The new vaccine reduces treatment to 3 or 4 injections and should provoke minimal reactions. Because of its highly antigenic property, this new vaccine should, in addition, make production of human rabies immune globulin feasible and ultimately lead to phasing out of the equine antiserum with all its problems.

With increasing levels of wildlife involvement in rabies — part of a world wide phenomenon — and consequent greater human exposure to the disease, the committee advises, amongst other measures, the creation of an efficient central authority to handle all aspects of rabies control, particularly those pertaining to public health and education. This would be a logical and desirable step in South Africa, where propaganda and educational programmes have been sadly lacking.

While not being a blue-print for final eradication of rabies, this Sixth Report of the committee is an encouraging document, since it chronicles considerable progress and brings the time when man will no longer be threatened with the unspeakable that much closer.

I repeat, all who work with, are exposed to, or have an interest in rabies, will find this an indispensable source of information.

C.D.M.

Jl S. Afr. vet. Ass. 44 (4) : 397—403 1973

PHYSIOPATHOLOGICAL FEATURES OF HEARTWATER IN SHEEP

N. C. Owen*, A. Littlejohn*, Johanna M. Kruger* and B. J. Erasmus**

SUMMARY

A number of physiological and biochemical observations were made on four sheep undergoing acute experimental heartwater. The essential features of the results were as follows:

1. The mean eosinophil counts dropped from 200 to 26 during the symptomatic phase of the disease. The initial decrease appeared to precede the onset of the febrile reaction.
2. The sheep maintained their cardiac outputs until the terminal circulatory collapse. This was achieved by increasing the heart rates from 97 to 131 beats/min to compensate for a stroke volume which decreased progressively from 59 ml to 42 ml min. This observation is apparently related to restricted ventricular filling caused by fluid accumulation in the pericardial sac.
3. The mean systolic and diastolic blood pressures fell from 103×10^2 Pa (77 mm Hg) and 80×10^2 Pa (60 mm Hg) to 69×10^2 Pa (52 mm Hg) and 48×10^2 Pa (36 mm Hg) respectively.
4. A transient respiratory acidosis was observed during the febrile phase of the disease. No evidence of metabolic acid-base disturbance could be shown.
5. The absence of any significant EKG changes suggests that primary conductive lesions in the heart are not a feature of the pathogenesis of heartwater.

INTRODUCTION

Despite the use of prophylactic immunization [5, 6] and broad spectrum antibiotic therapy [3, 11], heartwater continues to cause substantial losses amongst domesticated ruminants in South Africa. Little attention has been given to the physiopathology of the condition. Graf [2] studied blood constituents, while Clark [1] published the first comprehensive investigation into the changes in the blood constituents and in carotid blood pressure in sheep and cattle infected with heartwater. He interpreted his results as indicating terminal sympatholysis and loss of peripheral resistance. Of particular interest were his findings regarding cardiovascular and possible acid-base disturbances. A marked terminal loss of diastolic arterial blood pressure and plasma volume suggested a drop in peripheral resistance and an increased vascular permeability.

Since heartwater affects both heart and lung function profoundly, this investigation was aimed at further study of the pathogenesis of heartwater with special reference to the cardiovascular, respiratory and acid-base changes.

METHODS

Four sheep were infected with *Cowdria ruminantium* by intravenous injection of 10 ml fresh blood drawn from a donor sheep at the height of febrile heartwater reaction. Several parameters were studied simultaneously at suitable intervals during progress of the disease. To facilitate arterial blood sampling and blood pressure measurement the carotid artery of each sheep was fixed surgically in the subcutaneous position three weeks prior to the experiment. Rectal temperatures and respiratory rates were recorded daily, while blood samples and physiological observations were taken at suitably spaced intervals.

The various determinations and experimental procedures were as follows:

Blood Sample Analysis

Haemoglobin [12]; microhaematocrits (Ecco microcentrifuge); eosinophil counts [7]; plasma sodium and potassium (Beckmann atomic absorption system), and plasma chlorides (potentiometric titration—Gallenkamp).

Physiological Parameters

Cardiac output was determined by the Fick principle. A polythene cannula (Intramedic PE 100) was introduced into the jugular vein and advanced into the right ventricle. The position of the catheter tip was confirmed by recording typical ventricular pressure curves, using a pressure transducer (Statham DB 40 0-30 mm Hg) and a multi-channel recorder (Elema-Schönander Mingograf 81). In a few instances, catheterization of the right

*Dept. of Physiology, Faculty of Veterinary Science of t he University of Pretoria, Onderstepoort.
**Section Virology, Veterinary Research Institute, Onderstepoort.

ventricle was not achieved, in which cases right atrial blood samples were collected. The carotid artery was cannulated with a 22 gauge needle and attched to a second pressure transducer (Statham DB 40, 0-300 mm Hg) by means of similar polyethylene tubing used for collecting ventricular blood samples.

The sheep was finally connected to a 9 *l* spirometer (Warren E. Collins) containing pure oxygen and carbon dioxide absorber, by means of a plastic mask which was sealed and rendered leakproof by liberal application of silicone paste ('Silopren', Bayer Chemdyes, Johannesburg). After an equilibration period of approximately ten minutes, arterial and venous blood samples were withdrawn simultaneously. Arterial blood pressure was noted while oxygen consumption was automatically recorded over the entire period. The PO_2 and pH of the blood samples were determined immediately after collection, and the PCO_2 and standard bicarbonate were determined by the Astrup technique using a Radiometer BMS_2 and Digital Acid Base Analyser [10].

Aliquots of blood were used to determine haemoglobin concentrations and haematocrits.

Cardiac outputs were finally calculated from arteriovenous oxygen content differences and oxygen consumption. The oxygen content was calculated by means of the Blood Gas Calculator [9] using the dissociation curve for Merino sheep determined by Hilpert, Fleischmann, Kempe & Bartels [4].

Tidal volumes, minute volumes and respiratory rates were obtained by direct spirometry.

Continuous electrocardiographic recordings were taken with each determination of cardiac output using electrode placings described by Schulz, Pretorius & Terblanche [8]. Heart rates were obtained from the EKG tracings and, together with the cardiac outputs, were used to compute stroke volumes.

Animals were weighed after each experiment and the results expressed per kg body mass.

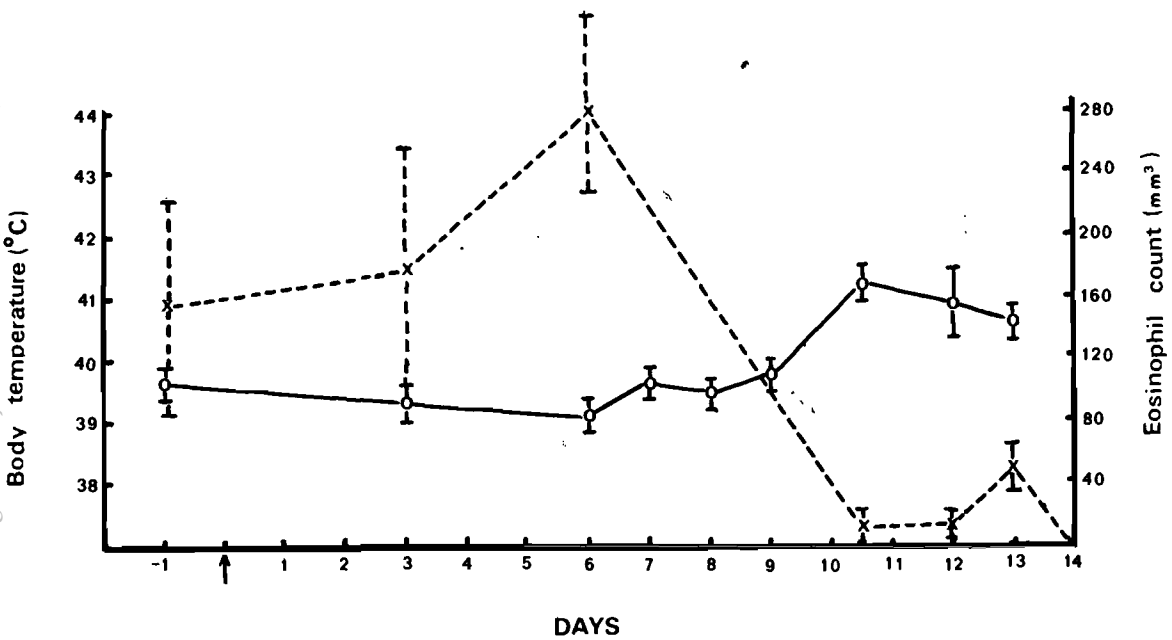

Fig. 1: The mean eosinophil counts (±1 SD) and body temperature during the experimental period.

- - - eosinophil count. —— body temperature. ↑ infection.

RESULTS

General Observations

All four sheep reacted to the disease as judged by their rectal temperatures. Using the suggested norm of 40°C [1], the incubation periods varied from 7 to 10 days. Three of the 4 animals died within 4 days of the onset of the reaction. One sheep recovered spontaneously.

The eosinophil counts rose initially and then dropped precipitously between the 6th and 10th days after infection. The mean eosinophil counts and the mean rectal temperatures over the experimental period are illustrated in figure 1.

The average body mass loss by the sheep was almost 6 kg over the experimental period.

The venous haematocrits and haemoglobin concentrations decreased gradually during course of the disease, while sodium and chloride concentration tended to rise somewhat during the febrile phase. Plasma potassium and bicarbonate concentrations declined slightly terminally. The mean values for these determinations are summarized in table 1.

Cardiovascular Changes

(a) *Haemodynamic aspects:* The arterial blood pressure declined gradually as the disease progressed. The systolic pressure fell slightly faster than the diastolic. In one instance, recorded shortly before death, the systolic pressure was only 40×10^2 Pa (30 mm Hg) while the diastolic pressure failed to register above atmospheric pressure. The mean systolic and diastolic pressures are given in table 2.

The apparent improvement on the 13th day is due to the fact that one sheep had died during the previous day.

Changes in cardiac output, stroke volume and heart rate are shown in figure 2.

Although the variation between sheep was large, the mean trends show that the cardiac output began to rise early in the course of the disease, i.e., before the onset of the febrile phase (cf. Fig. 1). The rise was sustained until just before the terminal stages, when the cardiac output dropped sharply. The initial increase in cardiac output was achieved mainly by an increase in stroke volume. During the febrile phase, however, the cardiac output was maintained largely by an increased heart rate, while the stroke volume decreased progressively.

(b) *Electrocardiographic aspects:* For comparative purposes the EKG results have been divided into two groups:

(1) those taken prior to the febrile phase

Table 1: MEAN VALUES (±1 SD) OF DIFFERENT BLOOD CONSTITUENTS DURING THE EXPERIMENTAL PERIOD

DETERMINATION	DAYS FOLLOWING INFECTION						
	0	3	6	10	11	12	13
Haematocrits (%)	22 ± 5	23 ± 3	24 ± 4	21 ± 4	19 ± 4	21 ± 4	21 ± 2
Haemoglobin (g%)	8,4 ± 1,0	8,8 ± 1,0	9,0 ± 1,4	7,6 ± 1,2	6,9 ± 1,3	7,4 ± 1,1	7,7 ± 0,2
Sodium (mEq/l)	138 ± 9	138 ± 15	149 ± 11	143 ± 12	144 ± 5	142 ± 4	136 ± 3
Chloride (mEq/l)	110 ± 3	112 ± 3	112 ± 4	110 ± 6	144 ± 5	113 ± 5	106 ± 3
Potassium (mEq/l)	4,4 ± 0,3	47 ± 0,2	4,9 ± 0,3	4,4 ± 0,2	4,3 ± 0,3	4,3 ± 0,7	3,8 ± 0,7
Bicarbonate (mEq/l)	—	20,7 ± 0,8	24,1 ± 2,1	21,4 ± 2,0	—	21,9 ± 1,7	20,8 ± 1,4

Table 2: MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE VALUES DURING THE EXPERIMENTAL PERIOD

PRESSURE	DAYS FOLLOWING INFECTION						
Pa × 10^2 (mm Hg)	0	3	6	10	11	12	13
Systolic	—	113 (85)	101 (76)	93 (70)	88 (66)	53 (40)	67 (50)
Diastolic	—	84 (63)	77 (58)	80 (60)	57 (43)	44 (33)	47 (35)

Figures in brackets : pressure in mm Hg.

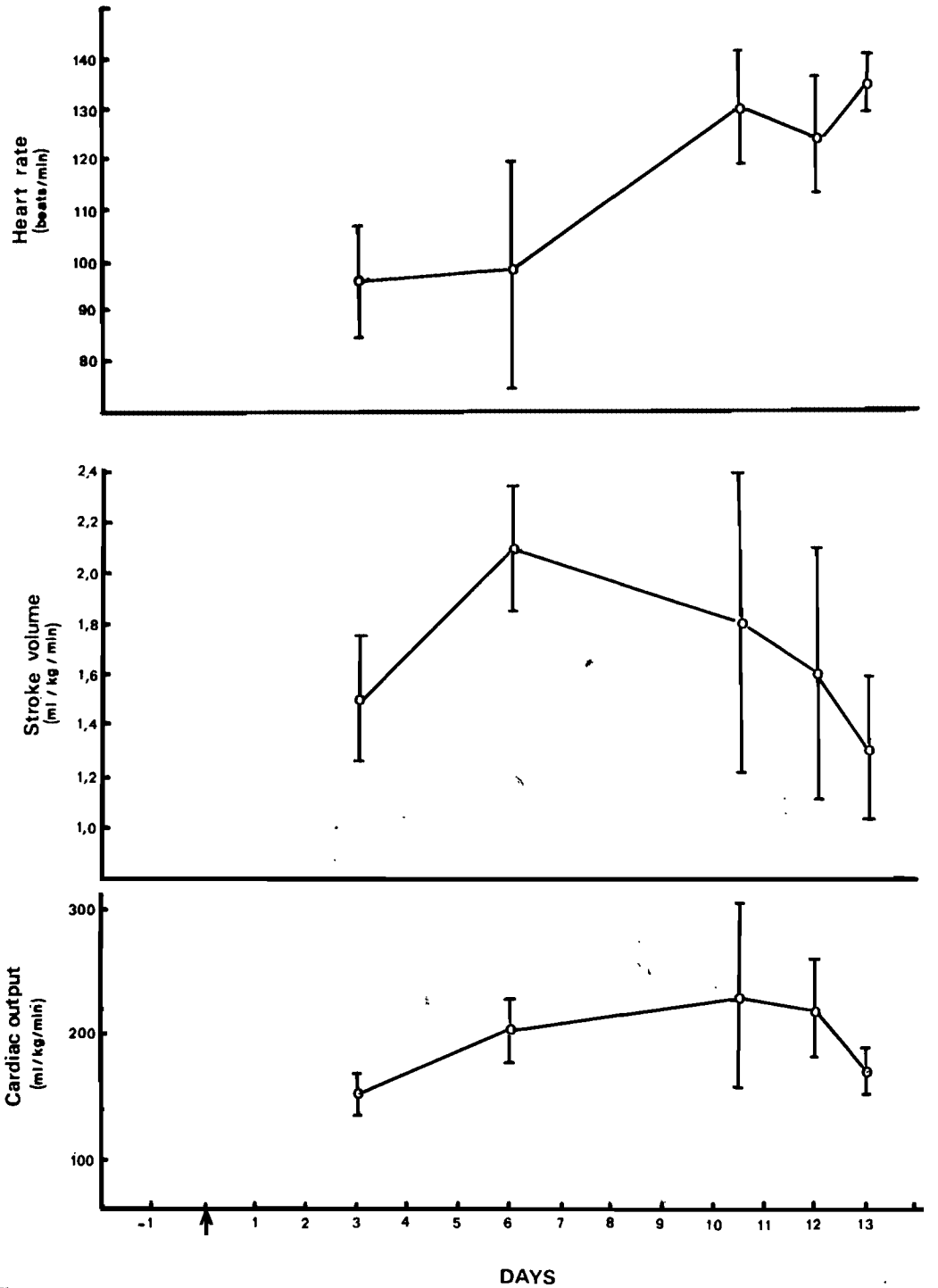

Fig 2. The mean value (±1 SD) of the the stroke volume, heart rate and cardiac output during the experimental period. ↑ Infection.

(during incubation); and
(2) those taken during the febrile phase.

The mean values for the various components are given in table 3.

The essential features of these results are a disappearance of the P-wave on Lead III, a slight decrease in the depolarization amplitude and a decrease in the QT-interval. In

Table 3: MEAN EKG TIME INTERVALS (s) AND AMPLITUDES (mV)

Lead	Phase of disease	PQ interval	QT interval	EKG COMPONENTS					
				P-WAVE		QRS-COMPLEX		T-WAVE	
				Duration	Amplitude	Duration	Amplitude	Duration	Amplitude
Lead I	Incubation	0,12	0,31	0,06	0,02	0,04	0,7	0,08	0,3
	Febrile	0,12	0,26	0,06	0,02	0,04	0,8	0,08	0,4
Lead II	Incubation	0,12	0,31	0,06	0,03	0,05	1,2	0,09	0,5
	Febrile	0,11	0,27	0,06	0,03	0,06	1,3	0,09	0,5
Lead III	Incubation	0,11	0,32	0,06	0,07	0,05	0,6	0,08	0,3
	Febrile	0	0,26	0	0	0,06	0,7	0,09	0,3

Table 4: MEAN VALUES (±1 SD) OF DETERMINATIONS OF THE ACID-BASE STATUS AND RESPIRATORY FUNCTIONS DURING THE EXPERIMENTAL PERIOD

DETERMINATION (Results expressed as means ± 1 SD)	DAYS FOLLOWING INFECTION				
	3	6	10	12	13
pH arterial	7,445 ± 0,008	7,435 ± 0,01	7,424 ± 0,014	7,309 ± 0,132	7,451 ± 0,014
PCO_2 Pa × 10^2 (mm Hg) arterial	41 ± 1,5 (31,0 ± 1,1)	49 ± 2,1 (36,5 ± 1,6)	45 ± 7,2 (34,0 ± 5,4)	61 ± 1,6 (46,5 ± 12,2)	41 ± 5,2 (30,8 ± 3,9)
Standard HCO_3 (mEq/l)	22,3 ± 0,8	23,7 ± 0,09	22,9 ± 1,1	21,0 ± 2,2	22,4 ± 0,9
Oxygen consumption (ml/kg/min)	289 ± 61	326 ± 50	311 ± 32	270 ± 52	276 ± 48
Respiratory rate (per min)	53 ± 1,4	24 ± 1,6	26 ± 3,0	41 ± 10,1	33 ± 6,2
Tidal volume (ml)	325 ± 40	456 ± 97	465 ± 46	516 ± 172	386 ± 60
Minute volume (l)	17,3 ± 2,5	10,8 ± 2,3	12,4 ± 2,6	22,5 ± 11,1	13,2 ± 4,3
Ventilatory* equivalent (l)	6,03 ± 1,70	3,29 ± 0,30	3,95 ± 0,52	8,24 ± 3,81	4,67 ± 0,79

*Ventilatory equivalent defined as volume of inspired gas required to give an oxygen uptake of 100 ml/min.

addition, occasional ectopic beats were recorded in the latter stages of the disease in a few instances.

(c) *Acid-base and respiratory findings:* The results relating to acid-base status and respiration as the disease progressed, are listed in table 4.

There was a tendency towards CO_2 retention and respiratory acidosis on the 12th day following infection. Standard bicarbonate values did not change significantly, thus indicating little or no metabolic component of the acidosis. Oxygen consumption increased somewhat before the febrile stage of the disease, while both the minute volume and the ventilation equivalent (VEO_2) increased significantly on the 12th day. This latter finding and the respiratory acidosis on the 12th day were associated with considerable respiratory distress. The initially elevated minute volume (third day) was due to excessive panting, possibly caused by excitement. Subsequent minute volume increases were due to increased tidal volumes and respiratory rates.

The ventilatory equivalent increased markedly on the 12th day, thus corresponding with the respiratory acidosis and acidaemia resulting from carbon dioxide retention. This finding is probably related to the pulmonary oedema observed at autopsy.

Autopsy Findings

The disease was confirmed by demonstrating the presence of the causative organism *(Cowdria ruminantium)* in the brain capillary endothelium. Two distinct forms of the disease were discernable at autopsy.

Two sheep had excessive fluid accumulation in the pericardial sac, while the other had a large amount of straw coloured fluid (approximately 775 ml) in the pleural cavity with only a few ml of fluid around the heart. The fluids contained fibrin-like material which clotted on standing.

In all animals variable sub-endocardial haemorrhages and pulmonary oedema were present.

DISCUSSION

The results are generally in agreement with those of Clark[1]. His conclusion that death results from a sudden loss of peripheral resistance (sympatholysis) is supported by the finding of a complete lack of diastolic blood pressure just prior to death in one instance. Nevertheless, his finding of increased pulse pressure could not be confirmed. This is probably related to the different techniques employed.

These results show only minor changes in the haematocrit and haemoglobin values. The terminal increases in these constituents may reflect increased capillary permeability.

The plasma sodium and chloride concentrations were well maintained until just before death, when both tended to increase. This finding may reflect loss of cell membrane integrity in the terminal stages. On the other hand the plasma potassium concentration decreased as the disease progressed. Since the sheep developed a respiratory acidosis at this time, these two aspects may well be related.

As noted by Clark[1], the circulating eosinophils decreased rapidly even before the onset of the febrile reaction. It is believed that this may be related to release of corticosteroids in response to the stress of the disease. The possible practical value of this finding with regard to immunization has not yet been studied.

The relatively large variations in response and the presence of two fairly distinct forms of the disease at autopsy suggest that the pathogenesis may follow different courses in different animals. Animals suffering from pronounced lung oedema and hydrothorax experience respiratory distress and may be expected to develop marked respiratory acidosis during the febrile stage. The three subjects surviving on the 13th day after infection were found to be significantly hypoxic. Their mean arterial oxygen tension whilst breathing atmospheric air was $77 \times 10^2 Pa \pm 2$ (58 ± 1 mm Hg), significantly lower than the normal value of $103 \times 10^2 Pa \pm 4 \times 10^2$ (77 ± 3 mm Hg) for this altitude, and this degree of hypoxia persisted until the day of death. The surviving subject was hypoxic for five days after its temperature returned to normal on the 14th day after infection. The three findings of respiratory acidosis, hypoxia and increased ventilatory equivalent for O_2 confirm the marked pulmonary dysfunction suggested by clinical and *post-mortem* signs. On the other hand, the accumulation of fluid in the pericardial sac appears to impair heart function. The decreasing stroke volume observed in these studies is ascribed to inadequate ventricular filling. This assumption is supported by the gradual drop in systolic blood pressure. A sudden drop in plasma volume[1] will lead to inability to maintain the cardiac output with resultant circulatory collapse. The progressive decline in diastolic pressure

points to a loss of peripheral resistance possibly resulting from central nervous damage caused by the parasite.

The EKG results also suggest that little if any primary cardiac damage occurs. Conduction appears to remain essentially normal as the changes observed are largely explained by the increase in heart rate.

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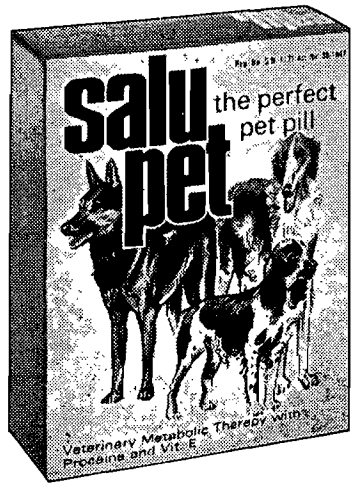

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OBSERVATIONS ON THE ECOLOGY OF *SCHISTOSOMA MATTHEEI* VEGLIA & LE ROUX, 1929, IN PORTION OF THE KRUGER NATIONAL PARK AND SURROUNDING AREA USING A NEW QUANTITATIVE TECHNIQUE FOR EGG OUTPUT

R. J. PITCHFORD*, P. S. VISSER*, J. F. DU TOIT*, U. DE V. PIENAAR** AND E. YOUNG***

SUMMARY

In order to study the ecology of animal schistosomes in their natural definitive hosts, a rapid and accurate method of quantitative estimation of faecal egg output was developed. The method is described in detail and its accuracy determined.

Over 1 300 faecal specimens from 23 wild animal species were examined from the southern section of the Kruger Nationl Park and compared with *S. mattheei* from six species of domestic animals surrounding this area. *Schistosoma mansoni* Sambon, 1907 was also investigated in the area immediately surrounding the Park.

It was concluded that viable *S. mattheei* populations within the Park fell into two groups: one local, in certain locally migratory animals such as waterbuck *(Kobus ellipsiprymnus)* and the other widespread in migratory animals such as buffalo *(Syncerus caffer)*.

Chance infections occurred in several animal species with eggs in faeces and there were probably undetected populations in species not excreting eggs.

There was not thought to be any undue mixing between schistosome populations inside and outside the Park borders.

INTRODUCTION

Natural schistosome infections in animals in Africa† have been reported frequently, often as a chance finding from autopsy material from sheep [7], cattle [1], numerous rodents and small mammals [5, 6, 12, 14, 16, 20-24], baboons *(Papio doguera)* [10], monkeys *(Cercopithecus mitis)* [13], hippopotami [9, 25], sea lions *(Zelophus californianus)* [2], and numerous others. Reports of natural infestations detected by examination of excreta of animals have been singularly few. *Schistosoma mansoni* Sambon, 1907, eggs were reported from faeces of one monkey *(Cercopithecus pygerythrus* syn. *C. aethiops)* from near Durban [19] and from 78 out of 277 faecal samples from about 100 baboons *(Papio anubis)* from Lake Manyara in Kenya [3]: *Schistosoma haematobium* (Bilharz, 1852) eggs were reported from the urine of two pigs in Nigeria [4]. *S. mattheei* has been found in animal and human excreta on numerous occasions but, as far as is known, no ecological studies of this parasite in its natural environment have been conducted. To do this today, recourse must be made to egg recovery from faeces. For the sake of game conservation many species are not available for direct recovery of adult worms. In Game Parks only a few species are selected for culling; examination of wild animal carcasses for schistosomes in the field presents numerous difficulties, which, nevertheless, can be overcome [8]. Serological methods are not specific and double or triple infestations may exist in many animals.

Domestic stock can be examined at abattoirs to the exclusion of many other possible definitive hosts, but to reach any conclusion regarding prevalence and worm loads considerable time must elapse before sufficient carcasses have been examined; meanwhile many conditions affecting transmission may change.

Egg recovery from animal faeces in the past has been tremendously time consuming, inaccurate, and laborious. It was essential, therefore, that some reasonably reliable, less time consuming, cheap and simple technique be developed for quantitative examination of animal schistosome eggs in faeces.

*Bilharzia Field Unit, South African Medical Research Council, Nelspruit.
**Assistant Director, Nature Conservation, Kruger National Park.
***Division of Veterinary Services, Kruger National Park.

†The Smithsonian check list for African mammals has been followed wherever possible. For species not yet listed, Roberts' 'The Mammals of South Africa' (1951) has been used.

††Faeces Filter. Manufactured by Labotec (Pty)Ltd., 61 Banfield Road, Industria North, P.O. Box 43161, Industria 2042.

Present egg counting techniques, although reasonably satisfactory for *S. mansoni* in human faeces, had to be discarded because of various characteristics of animal faeces; the method which was used was based on a recently described diagnostic filtration apparatus adapted for quantitative use††.

MATERIAL AND METHODS

(1) *Collection of Specimens*

All samples were collected in dry weather between 14/8/72 and 30/11/72; they were examined within a week of collection.

Between 10 and 50 grams of fresh animal faeces were collected off the ground, with as little soil contamination as possible and placed into small plastic containers of uniform mass, wih well-fitting lids (between 50 and 100 grams of elephant, rhinoceros and hippopotamus faeces was collected). Each sample was numbered and the number and species identification recorded. To each sample the same amount of 10 to 15 percent formalin was added in the field. It was necessary with some droppings (sheep, goats, giraffe and some antelopes) to crush the hard pellets manually before adding formalin. Thorough formalinization of eggs was ensured by shaking well in the field and waiting at least 24 hours before processing samples further.

(2) *Weighing*

All samples together with the formalin and container were weighed on return to the laboratory. Sample mass was calculated by subtracting the mass of added formalin plus container.

(3) *Filtration Procedure* (Fig. 1)

The weighed formalinized faeces of animals plus all washings were deposited in a standard sieve resting in a wide-mouthed plastic funnel held in a ring over the wide-mouthed fixed funnel of the filter. The filter hung clamped to a retort stand in a flat bottom metal bath. Faeces were thoroughly broken up manually and washed with water from a hose. The metal sieve and plastic funnel were removed and a jet of water from the hose directed directly into the inner filter. The outer filter was washed down with water from outside.

Human faeces were placed directly into the inner filter where they were easily broken up by a jet of water and manually through the walls of the filter while applying a jet of water.

Faeces were washed three or four times. The remaining contents of the outer filter were collected into a numbered 1 000 to 2 000 ml plastic canister by opening the wide

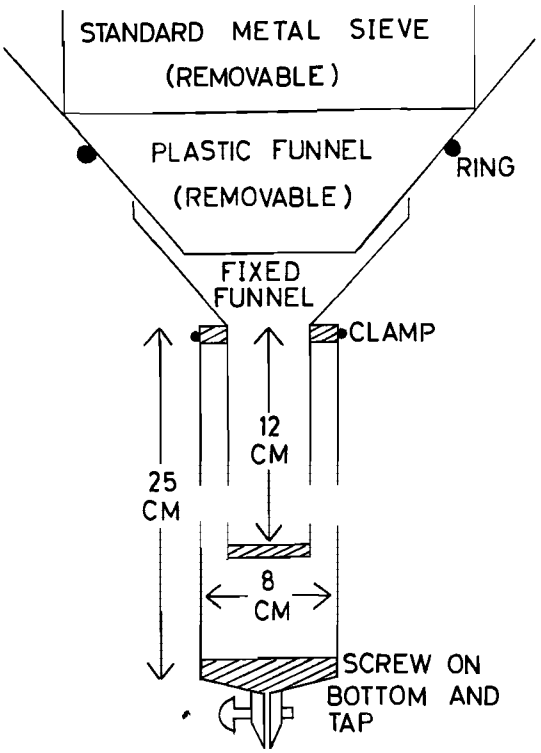

Fig. 1: Diagram of filter used for filtering faeces.

bore tap at the bottom and washing from outside with the tap open.

The meshes of the filters were as follows: Standard metal sieve: 251 μm (all large debris retained). Inner nylon filter: 95 μm (eggs and small debris passed through). Outer nylon filter: 50 μm (all eggs and some debris retained).

The capacity of the outer filter was $22/7 \times 4^2 \times 25$ cm^3, the inner filter $22/7 \times 1{,}5^2 \times 12$ cm^3. Precise capacities of the filters were unimportant, provided they were large enough.

The contents plus all washings of the large 1 000 to 2 000 ml container were poured into a calibrated Waring Blendor extended to hold about 2 000 ml and fitted with an 'open and close tot measure' half way up. In the present instance the blendor was calibrated at 1 460 ml and 1 095 ml, or $\times 40$ and $\times 30$ the capacity of the tot measure.

The blendor was filled with water to a fixed capacity and turned on slowly for thorough mixing. The tot measure was open-

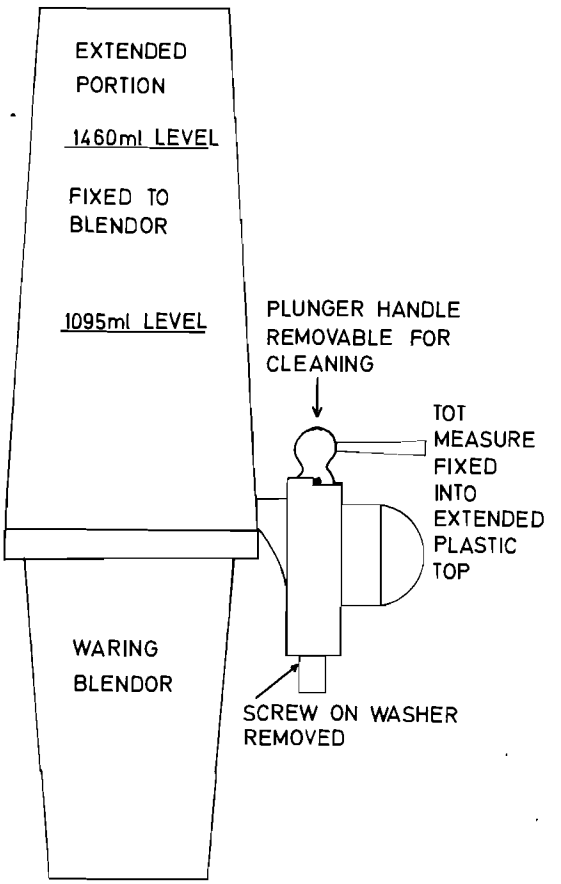

Fig. 2: Diagram of apparatus used for mixing and simultaneous removal of aliquot.

ed and the first tot allowed to run to waste. The second tot for staining was collected, with the blendor still mixing, into a thin-walled, small plastic container of 80 ml capacity and suitably numbered.

(4) *Staining*

Five ml stock acid fuchsin dye was added to the contents of each small plastic container and heated in a water-bath to between 70°C and 75°C. The containers were removed from the water-bath; the contents decolourized by adding stock NaOH solution and poured through No. 90 Whatman Filter paper contained in an extended bacteriological filter, washed with stock HCl solution until the colour reappeared in the filtrate, washed again with stock NaOH solution, again with the HCl solution, and finally with water to obtain even distribution of debris over the filter paper. The filter paper was removed from the filter and all eggs were counted while still wet in a lined petri dish using a stereoscopic microscope (3,5 objective, 10× eyepiece) and strong transmitted light.

The number of eggs per gram was calculated thus:—

$$\frac{\text{No. of eggs counted}}{\text{Mass of faeces}} \times \frac{30 \text{ or } 40}{\text{No. tots examined}}$$

Helminth eggs stained a brilliant pink to red and contrasted well with the umbers, ochres and madders of faecal debris. Paramphistome and *Fasciola* spp. eggs did not always take up the stain. With few exceptions faecal debris was left unstained.

One operator could complete the whole procedure in 15 to 20 minutes per sample. Three operators completed 80 to 100 samples

per day.

Stock dye and decolourizing solutions: The dye formula and technique for staining eggs was slightly different from that used for cercariae [15]. The stain was developed by the late Mr. A. H. Meyling and Mrs. J. Meyling. The decolourizing technique was developed later.

(A) *1 per cent Acid Fuchsin Solution*
Acid Fuchsin, water soluble (Hopkins & Williams) 2 g.
Distilled water 200 ml.
Heat slightly.

(B) *Sodium Sulphate/Hydrochloric Acid Solution*
Sodium Sulphate (Na_2SO_4. $10H_2O$) 30 g.
Concentrated HCl 34 ml.
Dissolve sodium sulphate in distilled water by heating slightly. Pour into 1 litre measuring flask. Add 34 ml concentrated HCl. Fill up to 1 litre with distilled water.

(C) *Stock Dye Solution*
Sodium Sulphate/HCl solution (B) 300 ml.
Distilled water 600 ml.
Acid Fuchsin solution (A) 200 ml.
Mix well by shaking.
The stock dye solution was stable for at least a few months under normal laboratory conditions.

(D) *Decolourizing solutions*
(a) NaOH 8,4 g.
Distilled water 6 660 ml.
(Not stable for more than 7 to 10 days).
(b) Conc. HCl 4 ml.
Distilled water 4 550 ml.

(5) *Accuracy of method*

Certain investigations regarding the accuracy of the method were necessary. These included the natural distribution of schistosome eggs in human and cattle faeces (Tables 1 and 2); egg recovery from negative human faeces to which known numbers of schistosome eggs had been added (Table 3); the periodicity of *S. mattheei* egg excretion in naturally infected cattle (Table 4). It was assumed that the findings regarding *S. mattheei* eggs in cattle faeces would apply to other animals.

Objections to the method are:

1) Each faecal sample must contain at least 30 eggs. This error is reduced with each additional tot measure or with larger faecal samples.
2) Abnormal hosts may not excrete eggs, e.g. hippopotamus [9]. This may be so, but these schistosomes would be of little importance with regard to transmission. The problem could be circumvented by culling or serology but with little addition to the over-all ecological picture.

DESCRIPTION OF AREA (Fig. 3)

Most of the area chosen for this survey was established as a game reserve in 1898. It is about 3 500 km² in extent and lies between 31° and 32° East and 25° and 25°30′ South. It embraces the whole of the southern section of the Kruger National Park lying between the perennial Sabi and Crocodile Rivers together with an adjoining area, ½—3 km wide, outside the Park. This comprises irrigated farm lands and Bantu Reserve along the whole of the southern, and western Park borders and the western half of the northern border of the study area. The remainder of the northern border of the study area is formed by the Sabi River flowing in a south-easterly direction through the Park. Moçambique forms the eastern border.

Apart from the perennial Sabi and Crocodile Rivers the only other rivers are the 'winter pooling' Sigasi River and its tributaries just inside the western Park border and the perennial Sand River flowing into the Sabi. Outside the Park numerous small streams, many of them acting as irrigation drains, flow into the Crocodile River in the south and into the Sabi River in the north.

The western third of the area comprises gently rolling park land about 800 m above seal-evel which gives way towards the east to flat acacia bush and falls to about 200 m above sea-level.

Summer rainfall varies from 750 to 850 mm in the west to about 500 mm in the east. Little rain falls in winter.

Water temperatures vary from occasional freezing along the rivers in winter to about 35°C in shallow waters in summer.

Two schistosome intermediate hosts, *Biomphalaria pfeifferi* (Krauss, 1848) and *Bulinus (Physopsis)* sp. are present throughout the Park area [13] and are most numerous in the irrigation systems along the Crocodile and Sabi Rivers, in the streams flowing into these rivers and in the Sigasi River and its tributaries. (Personal observations, R. J. P.).

The Park boundaries within the study area are fenced: in the North and South along the two rivers at high water mark on the far bank; along the western border, about 3 km west of the Sigasi River, and along the Moçambique/Transvaal border in the East.

Table 1: **S. MANSONI** EGGS RECOVERED PER GRAM OF HUMAN FAECES FROM DIFFERENT PARTS OF THREE STOOLS. (NATURAL INFECTIONS)

Stool	EGGS RECOVERED PER GRAM FROM SAMPLES 1	2	3	4	5	6	7	8	9	Mean	S.D.	Coeff. of variation %
1	832	904	897	920	932	1 023				918	57	6,2
2	2 156	2 192	1 932	2 377	—	—				2 164	158	7,3
3	3 536	4 368	4 526	3 395	3 554	3 776	4 150	4 274	3 770	3 928	387	9,8

Table 2: **S. MATTHEEI** EGGS RECOVERED FROM DIFFERENT PARTS OF CATTLE FAECES. (NATURAL INFECTIONS)

Sample mass grams	No. tots examined	No. S. mattheei eggs recoveretd total	per gram*
53	5	68	10
26	1	8	12
75	1	26	14
56	1	17	12
18	2	12	13
19	2	11	12
66	3	63	13

$$\text{*Total eggs recovered} = \frac{\text{mass of sample}}{\text{No. tots}} \times 40$$

Table 3: NUMBER OF SCHISTOSOME EGGS ADDED TO NEGATIVE HUMAN FAECES AND NUMBER RECOVERED

Mass stool	Number eggs added: Total S. mansoni	Total S. mattheei	per gram S. mansoni	per gram S. mattheei	Eggs recovered: per gram S. mansoni	per gram S. mattheei
7	328	178	47	25	46	23
5	108	28	22	6	16	4
6	15	211	3	35	3	23
4,5	90	116	20	26	18	27
7	95	98	13	14	13	9
8	300	131	38	16	35	10
8,5	300	543	35	64	37	44
5	300	225	60	45	56	72
4	723	—	181	—	160	—
4	200	—	50	—	40	—
6,5	675	—	104	—	132	—
4,5	150	—	33	—	44	—
3,5	—	83	—	24	—	23
6,5	300	150	46	23	67	18

Table 4: NUMBER OF **S. MATTHEEI** EGGS EXCRETED IN CATTLE FAECES OVER A 24 HOUR PERIOD

Date	Time of excretion	Number of eggs recovered per gram
25/10	18h00	4
26/10	06h30	3
26/10	11h00	4
26/10	15h00	6
26/10	18h00	5
27/10	06h00	5

Numerous wild animals species inhabit the Park, with minimal mixing between them and domestic animals in the adjoining areas.

RESULTS

(1) *Animals in the Kruger National Park*

For the sake of convenience the Park area has been divided into four (Fig. 3). Not all animal species were distributed evenly throughout the area (e.g., sable antelope, *Hippotragus niger*, and zebra, *Equus burchelli)* and in part this accounts for some not being examined in certain areas. Faeces were examined from 23 animal species, 11 of which contained typical *S. mattheei* eggs (Table 5). *S. mattheei* eggs were commonly found and evenly distributed throughout the area in buffalo *(Syncerus caffer)*, common in waterbuck *(Kobus ellipsiprymnus)*, fairly frequent in sable antelope and kudu *(Tragelephus strepsiceros)* and certain wildebeest *Connochaetes taurinus)* and some baboons *(Papio ursinus)*. One baboon was found excreting *S. mansoni* eggs. Positive findings in carnivore faeces might have indicated ingestion of eggs and only a few samples were examined.

Egg output of positive animals is shown in table 6. With the exception of two bushbuck *(Tragelephus scriptus)*, egg output per gram was not high.

(2) *Animals around the Borders of the Park*

Tables 7 and 8 show the results of faecal

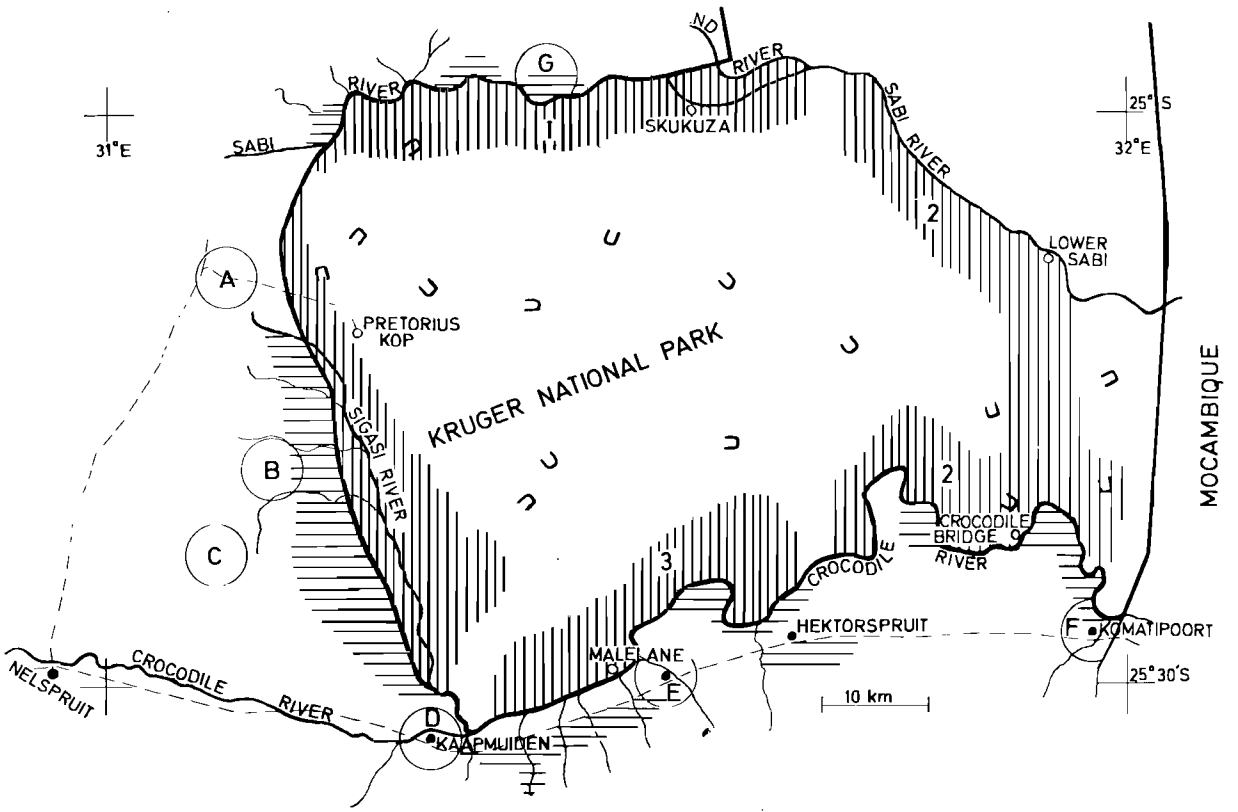

Fig. 3: Map of area surveyed: southern section of Kruger National Park and surrounding territory.

Areas surveyed outside Kruger Naetional Park.

Areas surveyed inside Kruger National Park.

Bantu children surveyed.

Townships.

Camps in Kruger National Park.

Man made dams.

Main roads.

Table 5: RESULTS OF FAECAL EXAMINATION FOR **S. MATTHEEI** OF ANIMAL SPECIES IN THE KRUGER NATIONAL PARK

Animal species	Area 1		Area 2		Area 3		Area 4		Total		Pos. %
	No. Exam.	No. Pos.	No. Exam.	No. Pos.	No. Exam.	No. Pos.	No. Exam.	No. Pos.	No. Exam.	No. Pos.	
Baboon	153	1*	49	21	41	1	37		280	22	8
Vervet Monkey	57		46	7	12				115	7	6
Carnivore (5 sp.)	4		2		7		4		17		
Elephant	33		16		7		38		94		
Zebra	1		11	1	20		34	1	66	2	3
Rhinoceros					5		33		38		
Hippopotamus	31		3		26		2		62		
Warthog	16				1		11		28		
Giraffe	10	1	6		2	1	19		37	2	5
Kudu	7	3	17				9	2	33	5	15
Bushbuck	23	2	3						26	2	8
Sable Antelope							33	6	33	6	18
Waterbuck	5		17	11	11	1	9	5	42	17	40
Reedbuck							7		7		
Wildebeest	1		18	1	16		86	11	121	12	10
Impala	36		25	5	41	3	91	1	193	9	5
Duiker							1		1		
Steenbok							5		5		
Buffalo	40	23	41	16	22	11	23	10	126	60	48
Total	417	29	254	62	211	17	442	36	1 324	144	—

Area 1. North western border⟿Sabi / Sand

2. Sabi / Sand⟿Lower Sabi⟿Crocodile Bridge

3. Malelane

4. Sigasi / Pretoriuskop

***S. mansoni**

Table 6: EGG OUTPUT OF **S. MATTHEEI** FROM ANIMALS IN THE KRUGER NATIONAL PARK

Species	NUMBER OF EGGS EXCRETED PER GRAM OF FAECES						Mean	Mass faeces per day (g)	Mean daily egg output per infested animal
	<2	3—5	—10	—20	—35	—50			
Baboon	12	5	3	2			3,6		
Monkey	2	4	1				3,7		
Zebra	2						1,5	3 626	4 939
Giraffe	1	1					2,5		
Kudu	1	1	1		2		11,8		
Bushbuck						2	46,0		
Sable Antelope		3	1	2			7,3		
Waterbuck	2	6	2	5	1	1	9,9		
Wildebeest	6	2	4				3,9	1 674	6 629
Impala	1	5	1	2			6,8	173	1 141
Buffalo	31	21	6	1	1		3,4	10 222	34 754

Table 7: **S. MATTHEEI** INFECTION IN DOMESTIC ANIMALS BORDERING THE KRUGER NATIONAL PARK

Animal species	BANTU AREA		EUROPEAN AREAS						TOTAL	
	Natural streams only. Western and Northern Borders		Irrigation canals and storage dams. Southern Border (1)		Troughs and natural streams sometimes. Southern Border (2)		Troughs only Northern and Southern Border (3)			
	Number examined	Number positive	Number examined	Number positive	Number examined	Number positive	Number examined	Number positive	Number examined	Number positive
Dogs	3	1*							3	1
Equines	4	0			1	0	2	0	7	0
Pigs	27	15†							27	15
Sheep	1		8	2	8	0	8	0	25	2
Goats	43	5							43	5
Cattle	129	97	39	36	76	16	49	0	293	149
Total	207	102	47	38	85	16	59	0	398	156
%Pos. (cattle only)	75		92		21		0		51	

*S. mansoni

†2 S. mattheei, 14 S. mansoni, 7 S. haematobium

Table 8: EGG OUTPUT OF **S. MATHEEI** FROM DOMESTIC ANIMALS

Species	NUMBER OF EGGS EXCRETED PER GRAM OF FAECES							Mean	Mass faeces per day (g)	Mean daily egg output per infested animal
	2	—5	—10	—20	—35	—50	+50			
Sheep		5						4		
Goats	1	2	2					5,6		
Cattle Bantu Area	35	36	13	9	3		1	5,7	10 000	57 000
,, European Area 1	14	6	9	7				6,2	13 000	80 600
,, European Area 2	12	4						1,6	13 000	20 800

examinations of six species of domestic animals. Findings were divided to correspond with the water provided for cattle.

Eggs of three schistosome species were present in pig faeces and *S. mansoni* eggs in the faeces of one dog. These findings probably reflected the coprophagous habits of these animals. On further investigation of pig faeces, all *S. mattheei* and *S. haematobium* eggs were dead. *S. mansoni* eggs produced very sluggish miracidia which were probably incapable of infecting snails, but the observation has not yet been investigated further.

(3) *Bantu children around the Borders of the Park*

Tables 9 and 10 show the *S. mansoni* prevalence and egg output of Bantu children living adjacent to the Park borders. These figures are not comparable with *S. mattheei* in animals but indicate theoretically the ease with which larval *S. mansoni* might enter the Park with possible enstablishment of the parasite in susceptible animals.

CHARACTERISTICS OF WILD ANIMALS EXAMINED IN RELATION TO SCHISTOSOME TRANSMISSION

Figures for longevity and mass have been taken from Mentis[8] and Wilson[28] respectively. Mass and other characteristics of faeces were noted during the survey. All population figures relate to the study area, i.e. between the Sabi and Crocodile Rivers, during 1972, according to official records of the Kruger National Park. Unless otherwise stated, habits of animals in the Park are the personal observations of two of us (U. de V. P. & E. Y.).

(1) *Baboons (Papio ursinus).* Mass up to 35 kg. Longevity: 20 to 25 years in capti-

Table 9: PREVALENCE OF **S. MANSONI** IN BANTU CHILDREN ROUND THE KRUGER NATIONAL PARK

Area surveyed (see map)	Year surveyed	No. examined	% positive
A Western Border	Current survey	29	45
B " "	" "	30	53
C " "	" "	30	43
D South-west corner	" "	75	97
E Southern Border	Numerous 1952—1963	—	80—90
F " "	" " "	—	70—80
G Northern Border	1963	33	39

Table 10: **S. MANSONI** EGG OUTPUT OF BANTU CHILDREN ROUND KRUGER PARK BORDERS

NUMBER OF EGGS PER GRAM OF FAECES

Area	1—50	—150	—250	—500	—1 000	—3 000	—6 000	+6 000
A	7			5		1		
B	6	2	2	2	1	2	1	
C	7	3	2		1			
D	3	5	8	13	20	18	4	2

vity. A rough estimate of the baboon population is several thousand.

Commonly found in troops of varying numbers. In the Kruger Park they often frequent water and may sometimes enter it for short periods. This is somewhat at variance with observations elsewhere, where the habits of the East African baboon were compared with those of a wet-footed malacologist. The discrepancy, however, may be due to the different species of baboon in East and South Africa, or to a greater prevalence of crocodiles in waters of the Kruger National Park.

Baboons are widely distributed throughout the Park and individual troops wander about locally, confining themselves to well marked areas of varying sizes. They are known to eat freshwater bivalves and might conceivably eat schistosome intermediate hosts, thus occasionally exposing themselves to infection. They sleep in trees or on rocky crevices at night, often near water where the ground is thickly strewn with their faeces.

The faeces are not bulky (about 140 gm per stool) but do not dry rapidly. Out of 280 samples, 22 were found containing eggs of *S. mattheei* and one of *S. mansoni*. Of the 22 positive *S. mattheei* faeces, 21 were from Area 2; three from the North along the Sabi River and 18 from a single troop in the South-east of this area, where they slept in trees about 20m from the Crocodile River.

(2) *Monkeys (Ceropithecus aethiops)*. Mass 5 to 7,5 kg. Longevity: up to 24 years. There is no estimate of their population numbers.

These animals are found in troops, usually in close proximity to tree-shaded rivers, which afford them protection at night. They seldom enter water but will occasionally wade through it in a hurry. They are widespread throughout the Park along the rivers and do not wander very far.

Their faeces are not bulky (about 75 gm per stool), are flattened out when dropped from a height and dry fairly rapidly. Out of 115 samples, seven were found containing eggs of *S. mattheei*. The positive findings were all from 46 animals along the Sabi River in Area 2.

(3) *Elephant (Loxodonta africana)*. Population: 633. An abundance of water is essential for drinking, wallowing, bathing, cooling and cleansing purposes. Herds of various sizes migrate for miles and they are common throughout the Park.

The droppings are very bulky and loose and made up of large portions of undigested vegetable matter. They remain moist for long periods even in hot weather. No schistosome eggs were found in 94 samples.

(4) *Zebra (Equus burchelli)*. Mass about 400 kg. Longevity: 20 to 25 years. Population 2 520.

Water is essential for these animals, which usually drink together in herds during

the day. They actively enter water, often up to their bellies, in company with other animals. Their peak drinking times vary from 09h00 to 15h00 during winter to 09h00 to 12h000 during summer[30]. Although the animals are common, they are not evenly distributed. They wander about from area to area depending on water and grazing.

The faeces are bulky (roughly 3 kg per day) and rather loose in texture and do not dry rapidly. Out of 66 samples two contained eggs of *S. mattheei*.

(5) *Rhinoceros (Ceratotherium simum)*. Mass: up to 2 250 kg. Population: 350.

Rhinoceros regularly visit water holes in summer or perennial pools in rivers during the dry season and spend much time wallowing. They are gregarious and occasionally wander. They mainly inhabit the western section of the study area.

The faeces are often deposited in one place and are bulky with loose texture and dry slowly. No schistosome eggs were found in 38 samples (37 *C. simum* and 1 *Diceros bicornis)*.

(6) *Hippopotamus (Hippopotamus amphibius)*. Mass: up to 1 900 kg. Population 670.

The habits of these animals are ideally suited to act as hosts for *Schistosoma* sp. They spend the whole day together, submerged, dropping their faeces in water and scattering them about with their tails. They occasionally wander from one water site to another and solitary animals may migrate in summer.

Droppings are soft and bulky and do not dry rapidly. No schistosome eggs were found in 62 samples.

(7) *Warthog (Phacochoerus aethiopicus)*. Mass: up to 100 kg. A population of 440 was obtained from estimates but the true figure almost certainly exceeds this.

Like their domestic relatives, warthogs will occasionally eat carrion but they are not carnivorous. They are diurnal and occur in small groups. They spend a great deal of time wallowing in shallow swamps and water holes, creating their own wallows at the edges of permanent pools. They are found throughout this section of the Park and do not wander far.

The faeces are fairly bulky but somewhat loose and do not dry rapidly. No schistosome eggs were found in 28 samples.

(8) *Giraffe (Giraffa camelopardalis)*. Mass: up to 1 100 kg. Longevity: up to 25 years. Population: 765.

Giraffe do not frequent water often but they drink regularly and may walk uncertainly through shallow stretches. On the whole they expose themselves to water rather timidly. They are gregarious and wander throughout this area of the Park.

Their faeces are hard and dry (about 450 gm per single voiding). Two out of 37 samples contained eggs of *S. mattheei*.

(9) *Kudu (Tragelephus strepsiceros)*. Mass: about 250 kg. Longevity: up to 15 years. Population: 1 100.

These animals can be independent of water and are sometimes found far from it. Nevertheless they will enter on occasions when drinking. They do not wander very far and are found throughout the Park in small herds or singly.

The droppings are hard and dry and weigh about 190 gm per single voiding (stool). Five out of 33 samples contained eggs of *S. mattheei* from Areas 2 and 4.

(10) *Bushbuck (Tragelephus scriptus)*. Mass: 35 to 60 kg. Longevity: 12 to 13 years. Possibly 1 000 of these animals inhabit this area of the Park.

They are solitary and inhabit thick bush never far from water. They drink during the day and enter shallow water and will on occasions swim through. They do not wander far and are found throughout the Park in suitable habitats.

Their droppings, about 85 gm per stool, are softish and do not dry out rapidly. Two out of 26 contained numerous eggs of *S. mattheei*.

(11) *Sable Antelope (Hippotragus niger)*. Mass: up to 250 kg. Longevity: up to 15 years. Population: 250.

Sable antelope are gregarious animals which enter water freely when drinking during the day. They are not migratory and are distributed mainly in the western section of this area of the Park in small to medium-sized herds.

Their droppings are soft and do not dry out rapidly. These weigh about 150 gm per stool. Six out of 33 samples contained eggs of *S. mattheei*.

(12) *Waterbuck (Kobus ellipsiprymnus)*. Mass: about 250 kg. Longevity: up to 16 years. Population: 395.

Waterbuck are gregarious animals occurring in small herds. They spend a considerable time in water and take refuge there when in danger. They are common throughout the Park and wander about locally only.

Their droppings are not hard, are easily broken up and remain moist for a long time.

These weigh about 450 gm per stool and are often deposited in water. Out of 42 samples, 17 contained moderate numbers of *S. mattheei* eggs; 11 of these were from south of Area 2.

(13) *Reedbuck (Redunca arundinum).* Mass: about 60 kg. There is no estimate of their population numbers but it probably exceeds 1 000.

They are solitary animals or occur in pairs or small groups in tall grassland and swamps with abundant water. They do not wander and are most common in the western section.

Their droppings are soft, easily broken up and often deposited in water. No schistosome eggs were found in seven samples.

(14) *Wildebeest (Connochaetes taurinus)* Mass: up to 250 kg. Longevity: up to 18 years Population: 1 172.

These gregarious animals occur in medium-sized to large herds, but solitary bulls are often found. They often enter water and wallow occasionally. Their peak drinking times are often 09h00 to 12h00 during summer and winter [30]. They wander about, depending on water and grazing and are found throughout the study area. The animals in Area 4 tend to remain in this area.

Their droppings (about 1,7 kg per day) are soft and loose and do not dry rapidly. Out of 121 samples, 12 were found containing eggs of *S. mattheei;* 11 of these were from Area 4.

(15) *Impala (Aepyceros melampus).* Mass: up to 65 kg. Longevity: 12 to 15 years. Population: 42 700.

These highly gregarious animals enter water occasionally for a short time while drinking but they can remain without wa'er for long periods. Their peak drinking times vary from 06h00 to 18h00 during summer and from 09h00 to 12h00 during winter [0]. They are not migratory and are found throughout the Park.

Impala have communal dung heaps, and their pellets, about 200 gm per day, are hard, dry and difficult to break up. Nine out of 193 samples contained eggs of *S. mattheei.* Five of these were from the southern section of Area 2.

(16) *Buffalo (Syncerus caffer).* Mass: up to 900 kg. Longevity: up to 20 years. Population: 2 728.

Buffalo are gregarious animals which occur in medium-sized to large herds. Water is essential. They drink during the day or night. Peak drinking times vary from 06h00 to 18h00 during winter and from 5h00 to 21h00 during summer [30]. They spend much time wallowing in shallow water. Many of the old solitary 'throw out' bulls spend all their time grazing or laying up in reed beds in rivers. They wander for miles but may spend some considerable time in any one particular area.

Their droppings, about 10 kg per day, are soft, easily broken up and often deposited in water. *S. mattheei* eggs were a common finding (50 per cent of 126 samples) and evenly distributed throughout the four areas.

HABITS AND CHARACTERISTICS OF DOMESTIC STOCK IN RELATION TO TRANSMISSION

The habits of these animals in relation to water are well known and are only mentioned briefly. Cattle enter water freely when drinking and often wade in streams. They often defaecate in water and their bulky droppings, up to about 13 kg per day, are wet and loose. They dry in the sun after about 24 hours. *S. mattheei* eggs were a common finding.

Sheep and goats are comparatively timid of water but sheep, if th rsty, will enter water and drink greedily. The droppings of both these animals are hard, rather dry and difficult to break up. Moderate numbers of *S. mattheei* eggs were found from some animals.

Pigs in the area had free range during the day and wandered about sometimes quite 'far from home'. None was ever seen wallowing in natural streams but they do have easy access to them. They are often kept as rubbish removers and their coprophagous habits, like those of dogs, are well known.

Although dogs have been incriminated as natural hosts of *S. mansoni* and *S. rodhaini* in Central East Africa [12] and pigs as natural hosts of *S. haematobium* in Nigeria [4], the present positive findings from one dog and several pigs are thought to be the result of ingestion of eggs, pending further investigation.

Animals in the Bantu Reserve were penned at night, which restricted their daytime movement. Cattle movement in the European areas was restricted by fencing and penning.

CHARACTERISTICS OF S. MATTHEEI WHICH HAVE A BEARING ON TRANSMISSION

(1) *Egg stage.* Eggs are excreted in faeces apparently without excretory periodicity. No hatching periodicity is known. Eggs die when dry but their viability in moist

faeces in the shade was at least four days (unpublished data).

(2) *Miracidia* stage. Intermediate hosts [*Bulinus (Physopsis)* spp.] are widespread and common throughout the Park in all types of water and in the area immediately surrounding it. These snails remain alive for several months in dried up water bodies (unpublished data) and are tolerant of the temperature variation within the area [18]. Incubation of *S. mattheei* from miracidia to cercariae at Nelspruit varied from 4 to 5 weeks in summer to about 20 weeks in winter [18].

(3) *Cercariae stage.* Long term studies under outdoor conditions at Nelspruit [15, 17] showed that cercariae of *S. mattheei* started to discharge about one hour after sunrise with peak discharge about two hours later. Shedding ceased six to eight hours after sunrise only to recommence in hot weather from about 21h00 for about two hours. Cercariae were discharged throughout the year with an increase in numbers and shedding snails during summer.

Initially up to 3 000 cercariae per snail were shed daily. This number was reduced to about half after about a month and continued to diminish with time and onset of winter. The halflife of shedding snails varied between two and four months depending on the season.

DISCUSSION

Within the boundaries of the Park the obvious distribution differential of *S. mattheei* in different definitive host species, e.g. buffalo (60 out of 126) and zebra (two out of 166), and in different groups of the same species, e.g., baboons in Area 2 (21 out of 49) and all other areas (one out of 231) provided a rough and ready means of classifying the various detectable schistosome populations as follows:

(1) Chance infections which would be unlikely to maintain themselves independently.
These included:

(a) the widely scattered populations in the common, gregarious, nomadic zebra, giraffe and impala, in which *S. mattheei* prevalence was low. Zebra and giraffe also had low egg output. Impala, in spite of their enormous numbers and relatively high egg output per gram, but relatively low daily egg output, are placed in this category because their faecal characteristics, like those of the giraffe, are not well suited to onward transmission of miracidia;

(b) the abnormally distributed populations in the solitary, non-wandering bushbuck with low prevalence and high egg output;

(c) the local population in the common gregarious, non-wandering, water-shy monkey with low egg output and low prevalence, and,

(d) those scattered populations in the widely distributed, nomadic, sometimes gregarious kudu with moderate egg output and prevalence but unsuitable faecal characteristics.

(2) Those which would probably be able to maintain themselves independently in local areas, because of the habits and suitable faecal characteristics of the definitive hosts, Those included:

(a) the populations in the locally distributed gregarious sable antelope and wildebeest in Area 4 which had moderate prevalence and egg output. Both species enter water freely when drinking and at other times;

(b) the populations in the water-loving, gregarious, non-wandering waterbuck with high prevalence and medium egg output, and,

(c) populations in certain baboon troops where entry of eggs to water was unimpeded and local.

(3) Those which in all probability would be able to maintain themselves independently over over wide areas.

These populations included the water loving, nomadic, gregarious buffalo: prevalence and daily egg output were high and no obstacle was presented to miracidia entering the water.

The fact that buffalo herds wander about the study area a great deal might militate against an independent schistosome population. Nevertheless, the study area was small enough for buffalo herds to return several times to previously seeded waters during the course of a year; the incubation period of *S. mattheei* (4 to 20 weeks) and the longevity of infected snails (several months) were sufficiently long to support an independent population. Besides, buffalo herds may remain in the same area for considerable periods.

In addition to the above detected *S. mattheei* populations, certain undetected

Schistosoma sp. populations almost certainly existed in this part of the Park. These were harboured by abnormal definitive hosts, with little chance of onward transmission because of non-excretion of viable eggs (e.g., hippopotami culled in the Park along the Letaba River some 100 km north of the Sabi River[9] which had an extremely high prevalence with heavy worm loads but the sites of infection and egg deposition prevented egg excretion). Other animals which might fall into this category include elephant, rhinoceros and warthog, all of which spend a considerable time wallowing and their droppings are suitable for onward transmission of miracidia, but they may not be susceptible to *S. mattheei*.

Alternatively, the whole *S. mattheei* population within the southern Park might be considered as being maintained in part, over wide areas, by buffalo and in part focally, by waterbuck, certain baboon troops, sable antelope and certain wildebeest herds. In this case the wandering habits of the buffalo would tend to militate against the indefinite survival of the *S. matthei* population.

The only other animal species examined in which evidence of schistosome infection was expected, was reedbuck, but only seven samples were investigated.

The carnivores examined included lions (3), leopards (4), small cats (5), wild dogs (*Lycaon pictus* (4) and a honey badger (1). No hyaenas were examined. Of the other larger animals inhabiting this area, the rarer one would probably not be able to maintain a schistosome population independently because of their scarcity, with the possible exception of otters; the water-shy, non-drinking habits and faecal characteristics of the commoner ones, like steenbok (*Raphicerus campestris*), of which 5 were examined, would preclude transmission.

No rodents were examined, but it is unlikely that any of the species inside or outside the Park would be capable of maintaining or spreading a schistosome population[16]. A possible exception is the cane rat (*Thryonomys swinderianus*).

It was noted that the prevalence and egg output of the common, highly gregarious, susceptible zebra and wildebeest outside Area 4 were low. These animals may form herds of several hundreds, they enter water freely, their faecal characteristics are suited to onward transmission of miracidia and their faeces are often deposited in water. Unlike the wallowing, more ponderous and sedate buffalo, they do create considerable disturbance in water, which may, over a long period, have some deleterious effect on snail hosts, especially in water denuded of vegetation. This characteristic would be unlikly to have any effect on cercariae. It might also be argued that because very large numbers of these animals enter water simultaneously, the chances of acquiring heavy worm loads would be small.

Outside the Park, schistosome population densities were influenced by activities of man, which encouraged increased host population and prevented host wanderings, which in turn resulted in water supplies which were favourable or unfavourable to the schistosomes.

Small 'winter pooling' streams provided water for the numerous cattle in the Bantu Reserve adjoining the western and part of the north-western Park boundary. Prevalence was 75 per cent and mean egg output 57 thousand per day per infected beast. European-owned cattle had three distinct types of water supply which markedly affected the schistosome population:

1) canals and night storage dams along the southern Park boundary supported a schistosome population of 92 per cent prevalence and a mean egg output of 81 thousand per infected beast per day;
2) troughs and occasional natural streams (during the course of rotational grazing) along the southern and northern Park boundary supported a schistosome population of 21 percent prevalence and mean egg output of 21 thousand per day per beast;
3) troughs with raw, piped water only, along the southern Park boundary, supported no detectable schistosome population (Tables 7 and 8).

S. mattheei populations in cattle were not thought to mix, because of the limited movement of the definitive hosts. Sheep and goats appeared to play but a small part in transmission because of their limited numbers.

Some of the findings suggested that there was very limited mixing between schistosome populations outside and inside the Park. Outside, the cattle prevalence was generally high, except in isolated circumstances, yet within the Park, around the borders, only one troop of baboons in the South-east of Area 2 supported a population of *S. mattheei* (18 infected out of 35). Only one baboon

Table 11: CHARACTERISTICS OF DEFINITIVE HOSTS RELATING TO TRANSMISSION

				FAECAL CHARACTERISTICS			ANIMAL HABITS					
Host species	Percentage *S. mattheei* prevalence	Egg output/g	Mass per stool (g)	Water content	Consistency	Deposited	Drinking	Entering water	Herding	Wandering	Total population	Longevity years
Baboon	8	3,6	140	medium	soft	mainly at sleep site	regular	seldom	may be large	all day	several thousand	20—25
Monkey	6	2,7	75	medium	soft	mainly at sleep site	regular	seldom	medium	slight	hundreds	up to 24
Zebra	3	1,5	3 626 (per day)	75–80% summer 65–72% winter	soft	sometimes in water	regular	freely	large	great	2 520	20—25
Giraffe	5	2,5	450	low	hard	anywhere	regular	timidly seldom	scattered	great	765	up to 25
Kudu	15	12	190	low	hard	anywhere	may be independent	seldom freely	medium	slight	1 110	up to 15
Bushbuck	8	46	86	high	soft	anywhere	regular	freely	solitary	no	hundreds	12—13
Sable Antelope	18	7,3	145	high	soft	often in water	regular	freely	medium	slight	250	up to 15
Waterbuck	40	9,9	540	high	soft	often in water	regular	freely often	medium	slight	395	up to 16
Wildebeest	10	3,9	1 674 (per day)	74–79% summer 63–69% winter	soft	sometimes in water	regular	freely	large	medium	1 172	up to 18
Impala	5	6,6	173 (per day)	63–73% summer 36–49% winter	hard	communal heaps	long intervals	sometimes	large	slight	42 700	12—15
Buffalo	48	3,4	10 222 (per day)	80–84% summer 77–81% winter	soft	often in water	regular	freely often	large	great	2 728	up to 20
Cattle (Bantu)	76	5,7	10 000 (per day)	high	soft	often in water	regular	freely	large	medium	3 000	up to 15
Cattle (European 1)	92	6,2	13 000 (per day)	high	soft	often in water	regular	freely	large	slight	500	up to 10
Cattle (European 2)	21	1,6	13 000 (per day)	high	soft	sometimes in water	regular	freely	large	slight	300	up to 10
Sheep	8	4,0	—	low	hard	seldom in water	regular	seldom	small	slight	100	up to 10
Goats	12	5,6	—	low	hard	seldom in water	regular	seldom	small	slight	500	up to 10

examined around the borders was found with *S. mansoni* eggs, in spite of very high prevalence and egg output in humans living adjacent to the Park borders. In addition, all running water within the study area flowed into or within the Park boundaries.

Spread of schistosomes externally from the Park was almost certainly limited by the surrounding fence, which, in time, has provided a barrier to all animals except baboons, monkeys and smaller animals and an occasional elephant.

Table 11 shows some characteristics of the definintive hosts which were found harbouring *S. mattheei*.

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THE SURGICAL APPROACH TO CANINE INTERVERTEBRAL DISC DISEASE*

S. B. Friedman, A. M. Simon and B. M. Shaw**

SUMMARY

In a general didactic review the anatomy and physiology of the intervertebral disc and the gross pathology of the lesion are briefly mentioned, as well as its incidence and distribution, and the clinical appearance of the patient. The neurological examination, radiographic diagnosis, selection of cases for surgery, methods of operative procedure, postoperative management and response are described. Finally 43 cases treated by the authors are analysed.

INTRODUCTION

During a period of 27 months 43 cases of intervertebral disc disease were treated surgically. The surgery was performed by one member of the team in order to give him as much experience as possible, while the other two members developed refined radiographic techniques to improve diagnosis and refined anaesthetic and monitoring techniques to maintain homeostasis during the often very prolonged operation.

Of the 43 cases, seven were referred to us by colleagues. We were exceedingly grateful for these referrals, not only on their own account, but as a good omen for the future of veterinary specialization.

ANATOMY

The intervertebral disc unites two consecutive vertebral bodies in lieu of a synovial joint. It consists of the outer fibrous laminated ring, the *anulus fibrosus,* which surrounds the central amorphous gelatinous mass, the *nucleus pulposus.* The collagenous fibres of the *anulus fibrosus* form a lattice pattern of fibres, running obliquely between the circumference of the vertebral bodies. It is thickest ventrally. Towards the *nucleus pulposus* it becomes more cartilaginous. The disc has a poor blood supply and may have a few nerve endings, accounting for some of the pain in animals suffering from disc disease.

Strengthening the *anulus fibrosus* dorsally and ventrally are the dorsal and the ventral longitudinal ligament, running the length of the vertebral column in the floor of the vertebral canal and along the ventral aspect of the vertebral column respectively.

In the thoracic region, from T2 to T11, a conjugal ligament *(ligamentum intercapitale)* runs from the ridge between the two articular facets on the head of the rib on one side to that of the opposite rib, thus connecting the two. It passes underneath the dorsal longitudinal ligament and over the intervertebral disc, thus adding to the strength of the *anulus fibrosus* in its dorsal sector. The intercapital ligament of T11 is small.

The spinal cord to vertebral canal size ratio in the canine allows very little room to manoeuvre and this factor plus the overall smaller size of the dog makes canine spinal surgery relatively more difficult than the same procedure in man.

PHYSIOLOGY

The disc acts as a shock-absorber. The nucleus is non-compressible but readily adapts to pressure differences by assuming a different shape. By virtue of the lattice arrangement of its fibres, the annulus is 'elastic' and can 'give' in any one direction (Figs 1 & 2).

The nucleus is under constant tension and if the annulus loses its ability to 'give', as when undergoing degeneration, then permanent protrusion of the annulus and herniation of the nucleus can occur (Fig. 2). The most important centre of mobility is at and about the anti-clinal vertebra, T11, and it is noteworthy that the highest incidence of disc prolapse occurs immediately posterior to this point, where the intercapital ligament is absent.

PATHOLOGY

Disc degeneration is likely to occur in old dogs, and in young dogs of the chondrodystrophoid breeds (Dachshund, Pekingese, etc.).

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**275 Ontdekkers Road, Florida Park Extension 3, Johannesburg, 2001.

The pathological process is one of dehydration, fibrosis, necrosis and eventually calcification. This process usually begins in the *nucleus pulposus* and then spreads throughout the disc. These changes do not necessarily cause a dorsal protrusion of the disc and therefore may exert no pressure on the spinal cord.

Stresses on certain degenerated discs may cause either a simple protrusion of the dorsal sector of the *anulus fibrosis* without rupture and escape of nucleus material, or the annulus may rupture, releasing all or part of the nucleus. The extruded material may undergo spontaneous resorption with remission of symptoms, or it may undergo fibrosis and later calcify.

The protrusion occurs most commonly dorsally into the floor of the vertebral canal but may also occur laterally, causing pressure on the nerve roots and pain. It can also occur cranialwards or caudalwards into the vertebral bodies (Schmorl node), causing no symptoms, or ventrally to calcify later and form an exostosis, which is usually also symptomless (Fig. 3).

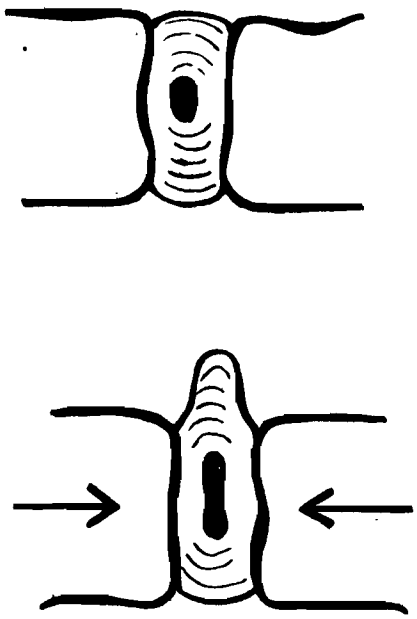

Fig. 1: Schematic representation in exaggerated form of protrusion of disc as result of pressure.

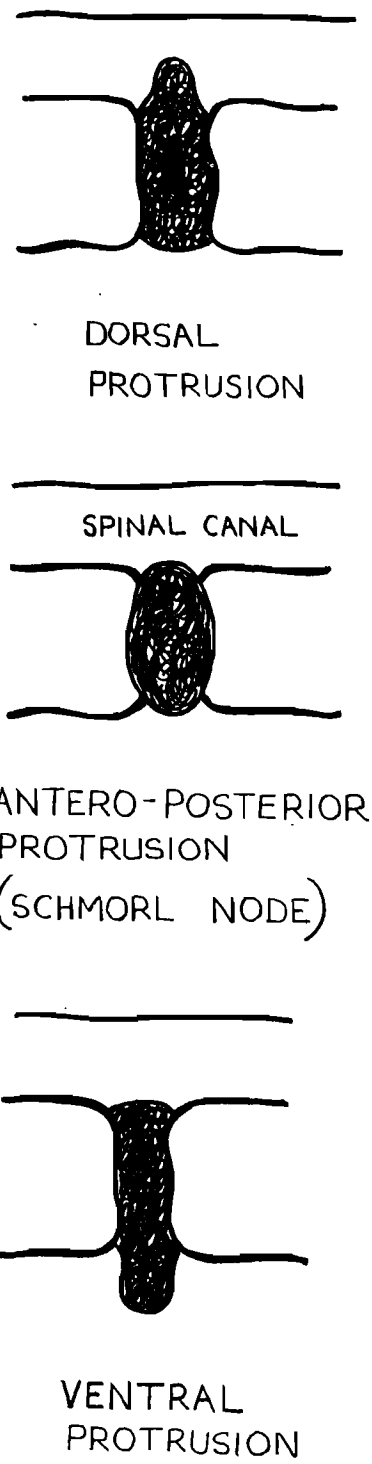

Fig. 3: Schematic representation of protrusion dorsa ward, cranio-caudalward and ventralward.

PATHOLOGICAL ANATOMY AND ASSOCIATED GENERAL CLINICAL SIGNS

Acute Disc Protrusion (Haemorrhagic Myelomalacia or Haematomyelia)

This is the less common disc 'explosion', causing widespread damage. Clinically the patient deteriorates rapidly with acute distress, inappetance, and ascending paralysis. Death may ensue owing to paralysis of the diaphragm.

Pathologico-anatomically there is a diffuse, red-grey colouration of the epidural connective tissue and fat, indicating necrosis. A large haemorrhage occurs in the epi- and subdural spaces. Medullary haemorrhage may be seen spread along the cord. The dorsal sector of the annulus is ruptured with widespread extrusion of nucleus material along the canal floor over several vertebral segments. Medullary arterioles have ruptured, the continual ooze causing demyelinization.

Chronic Disc Protrusion

This is the more common form. The onset of clinical signs is more gradual; the patient usually feels quite well and suffers no loss of appetite. The haemorrhage is slight and localized at the site of the lesion. It may have been into the epidural or subdural space, sometimes into the subarachnoid cavity. The protruded material may adhere to the dura mater and it may have surrounded the nerve root, so that the latter has become buried by it. Calcification of the herniated disc material may occur; the process may affect the necrosed epidural tissues as well as the dura mater. There may be a local venous stasis and cord oedema, and there may be a local myelitis, appearing as a grey-red indentation on the cord.

Fig. 2: Photo of protruded disc between L2—L3 in an aged Alsatian male with posterior paralysis. (Note degeneration in adjoining discs).

INCIDENCE OF CASES AND DISTRIBUTION OF LESION

Breed: The Dachshund heads the list: 60 per cent to 70 per cent of cases occur in members of this breed, followed by the Pekingese, and then by other members of the chondrodystrophoid group. Nevertheless, the disease can occur in any breed.

Sex: The disease occurs almost equally in both sexes.

Age: Approximately 75 per cent of cases occur in dogs 3 to 6 years old.

Site: In about 6 per cent of cases the lesion occurs in the thoracolumbar region (T11 - 12) and in about 12 per cent it is situated in the cervical area.

In a bout 70 per cent of cervical disc disease, the lesion occurs in the interspace between C2 and C3.

CLINICAL APPEARANCE

Dogs suffering from thoracolumbar disc disease are classified into three groups according to the degree of cord pressure and nerve tissue destruction.

Grade I: These cases are all ambulatory.

(a) There may be pain only. The abdomen is tense, and the back arched. The animal is reluctant to walk and, particularly to mount steps.
(b) There may be paresis only, as indicated by posterior inco-ordination and weakness.
(c) There may be a combination of (a) and (b).
(d) Bladder control is present.

Grade II: These cases are paraplegic but muscular tone is present. They usually sit with hind legs extended forward.

(a) They often suffer severe pain; voluntary motor function may be present or absent.
(b) Infrequently, there is no pain present; voluntary motor function may be present or absent.
(c) Bladder control may be unimpaired, partially present, or absent.

Grade III: These cases are totally paraplegic with no muscular tone, i.e. a flaccid paralysis is presented. The dog drags the hind limbs behind the body.

If sensory function is entirely absent, the prognosis is very poor.

(a) There is no pain.
(b) There is no muscle tone; atrophy develops rapidly.
(c) There is no motor function.
(d) There is no bladder control.

Cases suffering from cervical disc disease are classified into two groups, namely:

Grade I: Pain only; and

Grade II: Pain as well as a forelimb paresis, or even a tetraparesis.

(a) There is usually severe neck pain, which may be intermittent.
(b) The dog holds his head low to the ground with the neck rigid.
(c) The forelimbs may be affected by a unilateral or bilateral paresis with buckling of the feet. In advanced cases all four limbs are affected.

NEUROLOGICAL EXAMINATION

This consists of examination according to routine neurological methods of fore and hind limbs to determine:

1) voluntary motor function, whether reduced (paresis) or absent (paralysis);
2) muscular tone, whether normal, reduced (flaccidity or increased (spasticity);
3) spinal cord reflexes, which comprise the flexor, extensor thrust, patellar and crossed extensor reflex;
4) general sensory perception.

Hyperaesthesia indicates cord irritability at the level of the corresponding dermatome. Testing along the dorsum often produces a diagnostic hyperirritability at the segment associated with the cord lesion. This is a valuable diagnostic feature. Anaesthesia suggests severe damage to the cord at the level of the corresponding dermatome and is often also associated with some motor deficiency.

Evaluation of the results is undertaken to determine whether there is an upper motor neurone or a lower neurone deficit, i.e. whether there is damage of connecting fibres in the cord of central neurone origin, or damage to fibres and neurones of the cord itself. Table 1 shows how the lesion can be located. Specific reflexes can also assist to localize the lesion as shown in table 2.

Table 1: NEUROLOGICAL EXAMINATION

UPPER MOTOR NEURONE DEFICIT (UMN)		LOWER MOTOR NEURONE DEFICIT (LMN)	
1. Voluntary Motor Function	+ or −	1. Voluntary Motor Function	+ or −
2. Muscle Tone	++	2. Muscle Tone	+ or −
3. Reflexes	++	3. Reflexes	+ or −
4. Pain perception	+ or −	4. Atrophy	++

SITE OF LESION	EFFECT
C1 to C6	UMN all four limbs
C7 to T2	UMN forelegs
T3 to L3	UMN back legs
L4 to S3	UMN back legs
	LMN hindlegs

Table 2: NEUROLOGICAL EXAMINATION

PATELLAR REFLEX	SITE OF LESION	FLEXOR REFLEX	SITE OF LESION
−	L4 to L6	+ or −	C T & Cran. L
++	TL junction	Forelimbs −	C6 to T1
−	Haematomyelia	Hindlimbs −	L4 to S3
−	Femoral N. paralysis	All limbs −	Haematomyelia

PAIN REFLEX	SITE OF LESION
+	Most lesions
−	Lesions affecting spinothalamic tract

SUPERFICIAL SKIN PAIN REFLEX	
++	at site level (Diagnostic)

RADIOGRAPHIC DIAGNOSIS

Radiographs of the best quality are essential for accurate diagnosis. Positioning of the patient is important and there must be no movement. General anaesthesia is often necessary. A non-screen bucky technique gives more definition but a very powerful machine is required. The use of a high intensity intensifying screen requiring only about seven times the normal mAs provides a satisfactory alternative.

The lateral view is the more important diagnostically and the following are the criteria on which a diagnosis is based:—

1) A calcified nucleus indicates early disc degeneration.
2) A calcified nucleus plus calcification of part or the whole of the annulus indicates further degeneration. (NB. Disc. calcification alone is not diagnostic of disc prolapse).
3) A definite narrowing of the disc space is diagnostic.
4) A narrowed intervertebral foramen (closing of the contours of the 'horse's head') is also diagnostic.
5) An opacity in the spinal canal usually indicates calcified disc material but may be confused with dural ossification sometimes seen in senile dogs.
6) Osteophytes or completely calcified dorsal protrusions may be in the vertebral canal.
7) Ventral osteophytes or lipping on the poles of the vertebral bodies may be seen. These ventral exostoses may link to bridge the disc space and ankylose the joint. This lesion is known as spondylosis deformans and is common in old dogs. Although it develops as a result of disc degeneration at that site, it does not directly cause any symptoms.

When a diagnosis cannot be made from conventional radiographs, myelography becomes necessary. The authors have experienced this difficulty most often in cases of cervical disc disease and only rarely have had to resort to myelography for thoracolumbar cases.

The radio-opaque medium may be lipoid or aqueous. The former tends to break up into globules in the cerebrospinal fluid and this interferes with the result. To prevent this, it must be injected slowly and evenly The aqueous media are easier to use but may be more toxic. Fluoroscopy is virtually essential for observing the tracking of the dye over the floor of the vertebral canal and thus outlining a protrusion not large enough to cause a complete blockage. The authors manage without fluoroscopic screening but often find it frustrating and time consuming to tilt the patient to pool the dye in the desirable position and then to expose plates at intervals to read a result.

The introduction of the dye at the cisterna magna or in the lumbar region (usually L-4-5 or 6) is a straight-forward procedure, the technique being simple but demanding some prior practice on cadavers.

SELECTION OF CASES FOR SURGERY

Surgery should not be regarded as a last resort. It is well known that in some cases spontaneous recovery occurs. Grade I cases can recover clinically in a few days without any treatment, providing much satisfaction to the clinician who has employed medicinal or physical therapy in the form of manipulation, stretching, ultrasound, etc. It is perhaps not so well known that the relapse rate is rather high and can be reduced substantially by effective surgery. Because almost 70 per cent of disc cases occur at the thoracolumbar junction, it is essential to fenestrate as many spaces in this region as is practicable. This procedure causes the disc to be replaced by fibrous tissue, thus stabilizing the space and permanently preventing prolapse at the site.

The authors select cases on the following basis:—

1. Grade I cases are treated conservatively as a routine, unless they are recurring cases, or if they do not improve in spite of treatment after two to three weeks, when surgery is advised.
2. Grade I cases deteriorating to Grade II and all established Grade II and Grade III cases are recommended for surgery with the qualification that the prognosis in Grade III cases is fair to poor if there is no sensory function in the hind limbs whatsoever and also if they have been established longer than a week. Grade II and III cases are regarded as emergencies and surgery should be undertaken as soon as possible.

Contra-indications for surgery are:—

1) Unhealthy patients with organic disease. Screening for kidney and liver function is recommended, especially in

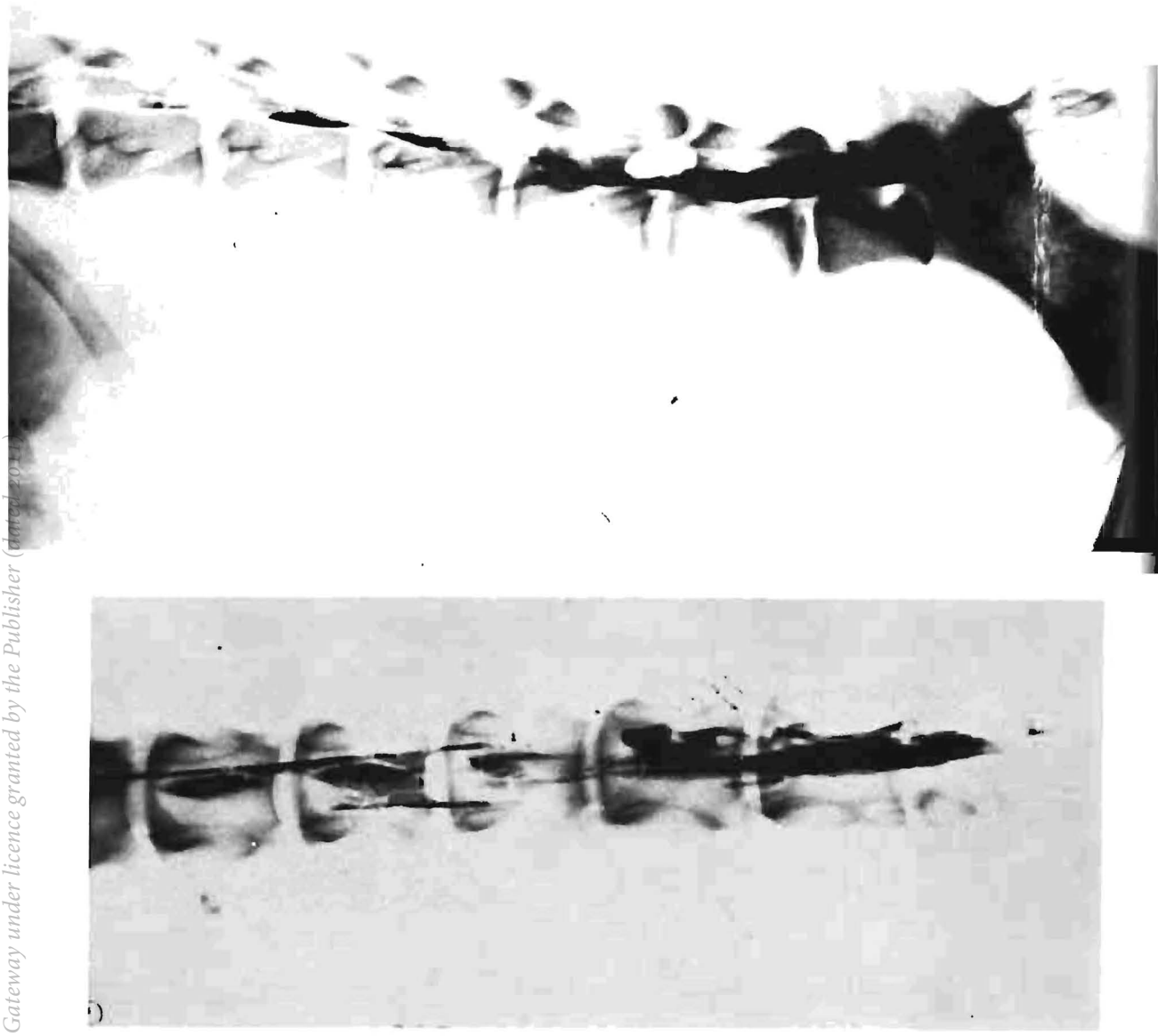

Fig. 4 and 5: Myelograph. Lateral showing outline of dorsal protrusion at L4—5 and VD. showing interruption of the dye at the same site.

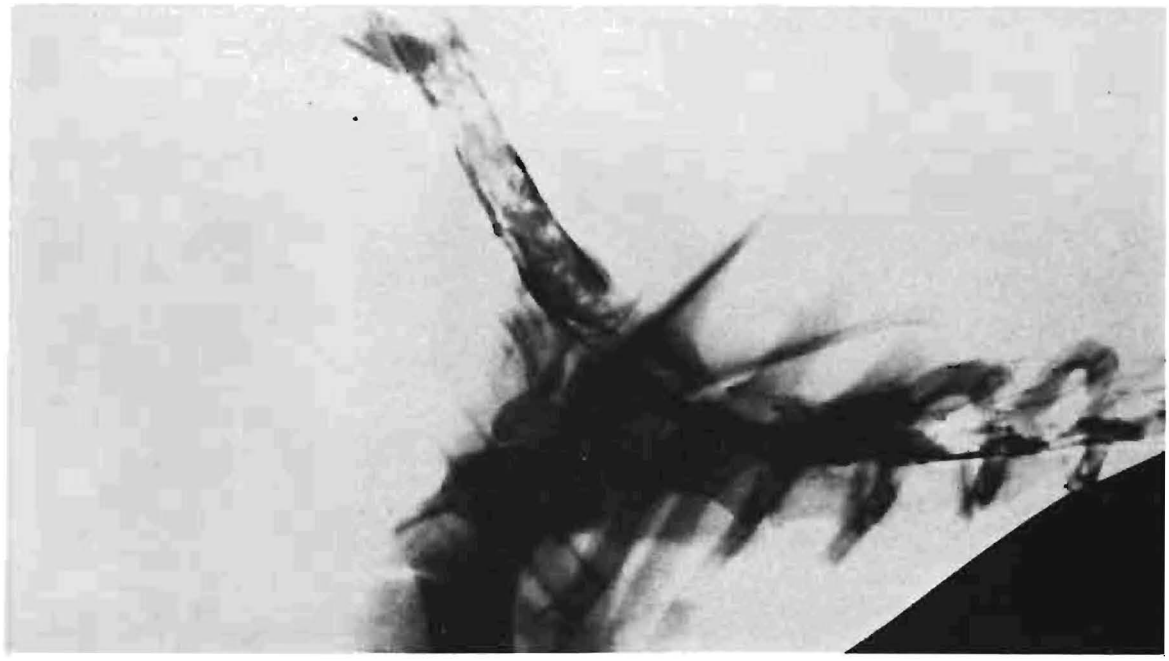

Fig.6: Myelograph. Lateral showing the dorsal protrusion at C6—C7.

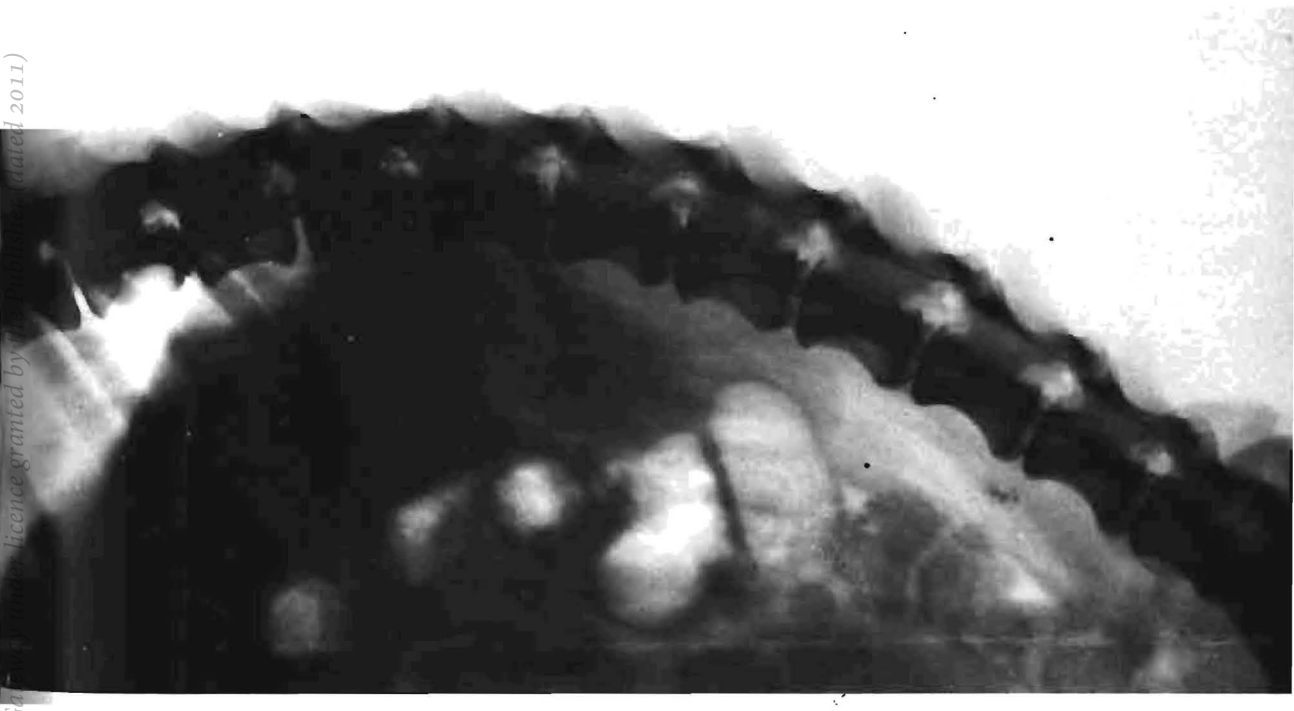

Fig. 7: Lateral view. Calcification of the disc and calcified material in the spinal canal (in the i.v. foramen) of L2—3. The calcification at T11—12 was of no symptomatic significance.

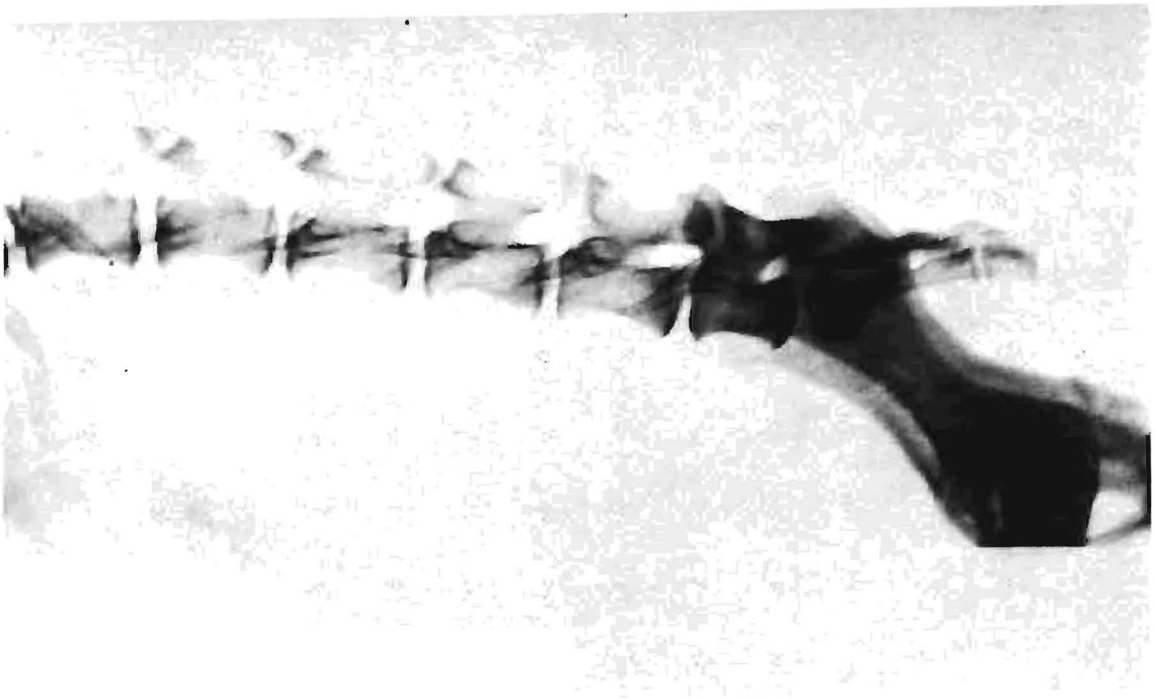

Fig. 8: Lateral view Calcification within the spinal canal at L3—4. Calcified disc L1—2.

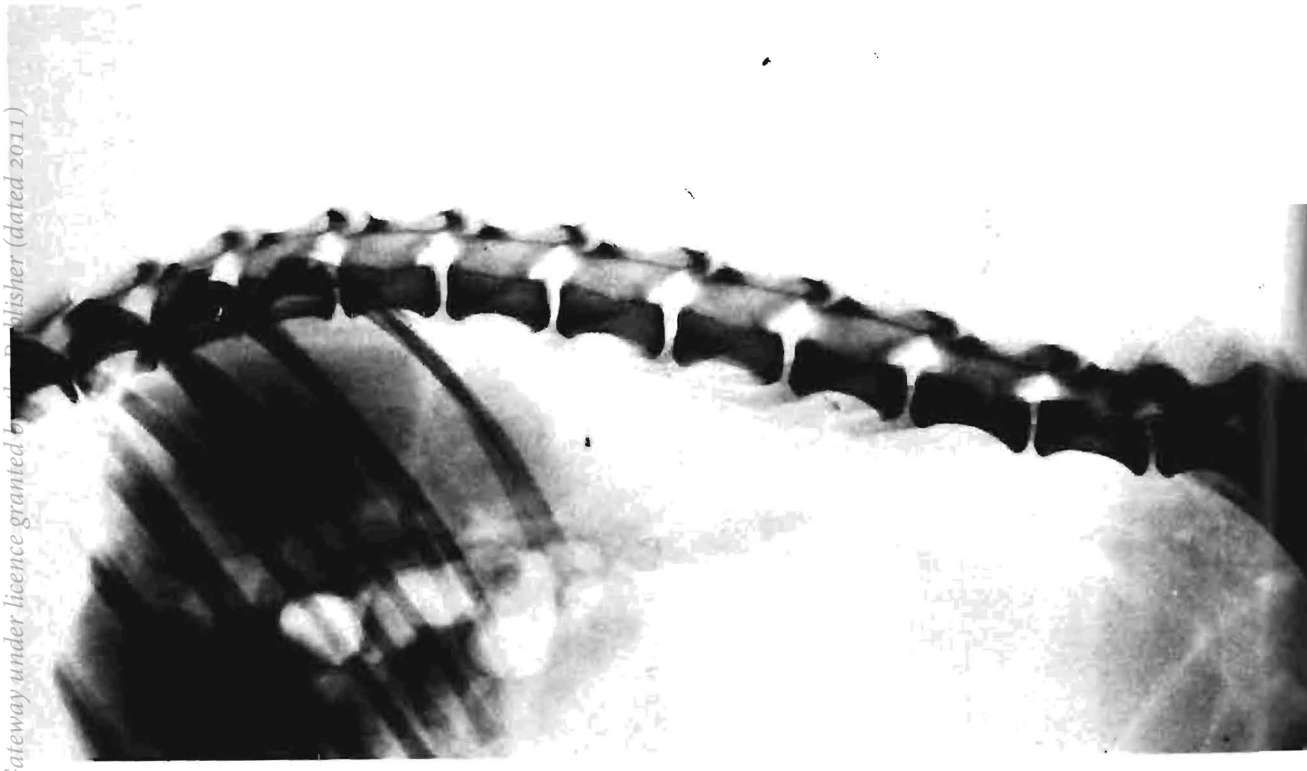

Fig. 9: Lateral view showing typical diagnostic narrowing of the L1—2 interspace.

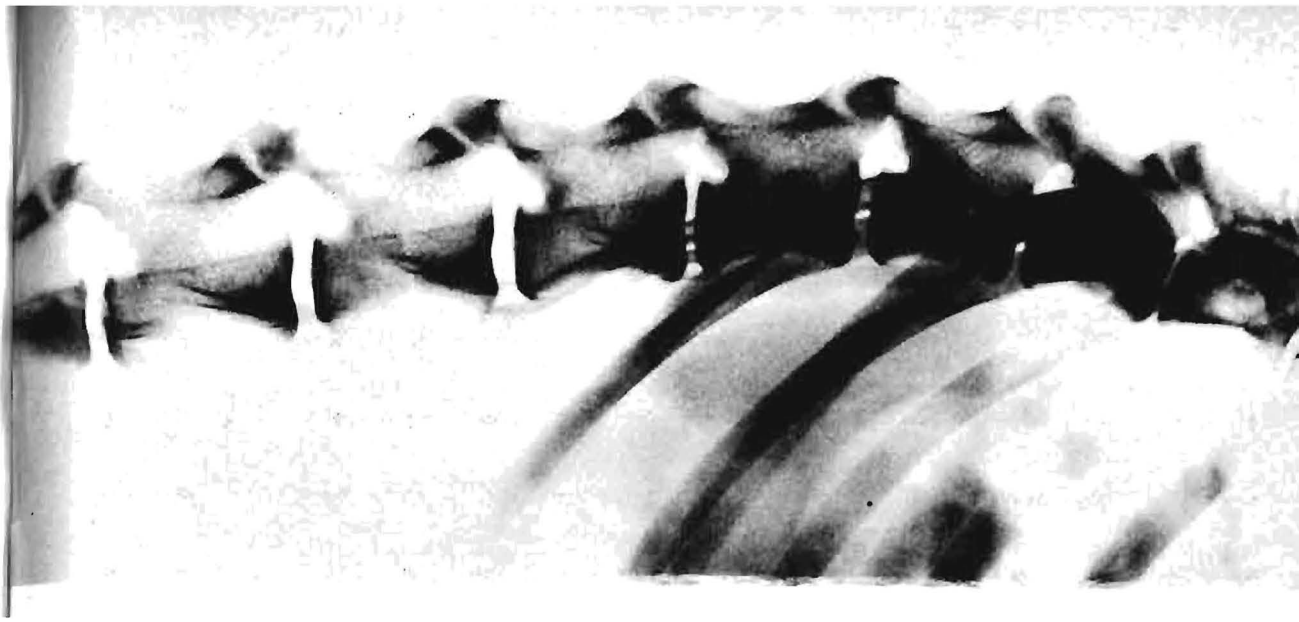

Fig. 10: Lateral view showing typical diagnostic narrowing of the T12—13 interspace.

Table 3: THE OUTCOME OF SURGERY PERFORMED ON 43 CASES OF DISC DISEASE*

TYPE OF CASE	CERVICAL			THORACOLUMBAR							TOTAL
				Grade I			Grade II		Grade III		
Type of surgery	D†	H††	F†††	D	H	F	D	H	D	H	
No. of cases	1	2	2	2	5	2	9	7	8	5	43
Successful	1		1	2	4	2	8	4	4	2	28
Failure		2	1		1		1	2	2	1	10
Deaths								1	2	2	5

*Including 4 cases of fracture/luxation.
†D—Dorsal laminectomy
††H—Hemilaminectomy.
†††F—Fenestration only.

Note: Whenever dorsal laminectomy or hemi-laminectomy was done, as many adjacent discs were fenestrated as was praticable.

Comment: Successful designates patients fully functional within 3 months after surgery, walking well and without any pain.
Failure—those not walking within 3 months even though there may be neurological improvement, and those patients still having pain (in the case of Thoracolumbar Grade I and Cervical cases).
Deaths—those patients who died during the first week post-operatively of causes other than the surgery (renal failure in most cases).

older patients. Long standing paraplegic cases with prolonged urinary stasis and back pressure are particularly vulnerable to renal decompensation following surgery and in any case have often suffered irreversible cord damage.

2) Patients with multiple lesions (possibly cervical and thoracolumbar).
3) Ascending paralysis (haematomyelia).

OPERATIVE TECHNIQUES

Dorsal laminectomy involves removal of the dorsal spinous processes and the dorsal laminae between the articular processes. Decompression is excellent and visualization of the cord is good. The main disadvantage is that the floor of the canal cannot be seen and osteophytes or disc material cannot be removed from under the cord.

Hemilaminectomy or the dorsolateral approach involves the removal of the cranial and caudal articulating processes and the lateral lamina on one side. Decompression is excellent and visualization of the cord and canal floor is good, but on one side only. The spinal nerves and blood vessels should be preserved. Haemorrhage from the ventral venous sinus often poses quite a problem. The disc can be evacuated easily and the prolapsed material removed readily from the canal on the same side. A recently acquired micrometer trephine [7] appears to offer a safe and efficient means of considerably reducing surgery time, when performing either dorsal laminectomy or hemilaminectomy.

Fenestration is the safest technique. The approach for cervical discs is ventral and for thoracolumbar discs it can be ventral (transthoracic and/or trans-abdominal), or most usually lateral (extrapleural and/or extraperitoneal).

Fenestration provides inadequate and slow decompression and no cord visualization, but it stabilizes the disc space by forming hard fibrous tissue. Fenestration alone is employed mainly for Grade I cases, especially cervical, and is generally used in combination with both the dorsal and hemilaminectomy technique to prevent relapses. As many discs as possible are fenestrated at the same time as laminectomy is performed.

POST OPERATIVE MANAGEMENT

Initially corticosteroids were used routinely to counter cord oedema but latterly this practice has been discontinued, as flare-ups of chronic inflammatory processes maybe precipitated. Antibiotic coverage is employed prior to surgery and for a week thereafter.

Incontinent patients must be assisted three times daily. Bitches are usually easily expressed manually but males have to be catheterized; as sterile a technique as possible is important to prevent introduction of infection. Retention catheters and plastic bags are the most effective way of insuring good hygiene and maintaining a constant flow without concomitant back pressure.

The patient should be kept clean of faeces and urine, otherwise dermatitis and decubitus will become a problem. Foam rubber mats should be placed in the cage and changed whenever soiled.

The patient is placed in the two-wheeled carriage as soon as possible, at first for only a short time until he adapts to it, and then for longer periods at more frequent intervals. The carriage is a valuable aid to prevent decubitus, to exercise all the muscles and is also very important to rehabilitate the patient psychologically. A happy, well-adjusted patient will make a faster recovery.

Thermal whirlpool baths, massage and passive muscle exercise prevent atrophy and stimulate regeneration.

POST OPERATIVE RECOVERY

Grade I cases usually show improvement after the second day. The pain gradually reduces and the legs become stronger. Most cases are discharged after a week.

Grade II cases may be ambulatory after a few days, i.e. becoming Grade I cases and progress further daily.

Grade III cases generally respond as follows:—

a) Bladder function is restored between 7 to 10 days.
b) Sensory perception returns in 18 to 20 days.
c) Voluntary movement returns at about 21 days.
d) The patient becomes ambulatory at about 30 days.

Patients showing no neurological improvement at all after three to four weeks are regarded as candidates for euthanasia.

ANALYSIS OF CASES

In a three-man small animal practice thirty nine cases of intervertebral disc disease have been treated surgically. In addition 4 cases of fracture/luxations were seen. Analysis of these cases yielded the following information regarding the incidence of disc disease.

For interest we include our distributional findings only on the 39 cases but in our table of results we include the fracture/luxation cases because they are symptomatically and surgically identical, except for subsequent immobilization, which is of no interest here.

The results are given in table 3.

We attribute the poor results of cervical cases to the fact that two were tetraparesis cases with severe prolapse at C6-C7 and C7-T1 respectively. Both these cases improved neurologically and had no pain following the surgery but permanent deficit of the one forelimb occurred in the one patient and the other patient ruptured another disc and developed renal complications.

The diagnostic and surgical procedures were found to be time consuming and possibly uneconomical in most instances, but the results were rewarding and justify continuation of the programme.

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THE FREQUENCY AND DISTRIBUTION OF CYSTICERCI IN SOME MUSCLES OF CALVES EXPERIMENTALLY INFESTED WITH OVA OF *TAENIA SAGINATA* GOEZE, 1782

L. W. VAN DEN HEEVER*

SUMMARY

Experimental infestation of five calves with ova of *Taenia saginata* resulted in a remarkably symmetrical distribution and frequency of cysticerci in the shoulder and masticatory muscles of the two sides of their carcases. Lack of walking exercise did not influence the degree of cysticerosis in the shoulder muscles. Data are provided in tabular form.

INTRODUCTION

To elucidate the question of distribution of cysticerci in muscular tissue and the contention that exercise influences the location of cysticerci in various muscle groups, an experiment was carried out. These matters are of interest in the rationalization of routine meat inspection procedures.

METHODS AND MATERIALS

Suspensions of ova of *Taenia saginata* Goeze, 1782 were administered *per os* to five cross-bred calves one to three days of age, by means of a dosing syringe. The calves were housed on wire mesh in individual cages measuring about 1,3 m^2 and of which the floors were raised some 50 cm above the ground.

At periods varying from 77 to 131 days after infestation the animals were slaughtered and subjected to a detailed examination for cysticerci. The flexor muscles of the shoulders (long, medial and lateral heads of *M. triceps brachii*, *M. infraspinatus* and the *pars scapularis* of M. *deltoideus)* and the large mandibular muscles *(M. masseter* and *M. pterygoideus)* were dissected out, weighed, shredded and subjected to scrutiny for cysticerci. The cysticerci were eventually counted and expressed in absolute numbers as well as number per unit of mass of muscle. The relevant data are summarized in the table.

DISCUSSION

These results, admittedly on a small number of animals, show a marked tendency to a singularly high order of symmetry of frequency of cysticerci in paired muscles of the right and left sides of the body. This observation applies to both heavy and slighter infestations.

There appears to be no linear correlation between the number of ova administered *per os* and the degree of eventual muscular cysticercosis.

The ratio of degree of infestation of shoulder to masticatory muscles is also of interest. Various authors[1, 2, 3, 4] have emphasized the value of the shoulder incision in the routine inspection of cattle for cysticercosis in East and Southern Africa. Others contend that this applies only to certain breeds[5, 6] and to range cattle, the parasite being said to be more likely to localize in active muscles well supplied with blood owing to regular exercise. The calves in this trial were closely confined from birth to slaughter and had no walking exercise whatsoever. The shoulder muscles of two calves yielded more cysticerci/g than was found in their jaw muscles, in one calf the degree of infestation was almost the same, and in the remaining two calves the shoulder muscles harboured fewer cysticerci. This would indicate that lack of walking exercise had no material influence on the degree of infestation of the shoulder muscles in these calves when compared with the number of cysticerci present in the muscles of mastication. There is, therefore, no justification for relinquishing the shoulder incision as a routine procedure[7, 8] in the inspection of intensively raised cattle.

ACKNOWLEDGEMENT

Acknowledgement is gratefully accorded to Miss Marie Collins, Dept. Parasitology, who furnished the ova and assisted with infestation of calves, and to Mr. J. J. van Staden who undertook the tedious work of counting the cysticerci and collecting the data.

*Dept. of Pathology, Faculty of Veterinary Science of the University of Pretoria, Onderstepoort.

Table: RESULTS OF EXPERIMENTAL INFESTATION OF FIVE NEWBORN CALVES WITH OVA OF **T. SAGINATA** GOEZE, 1782

Calf Carcase		Number of ova administered	Slaughtered on Day	Left Shoulder Flexors			Right Shoulder Flexors			Left Jaw Muscles			Right Jaw Muscles			Cysts/ 100 g Muscle (mean)	Infestation Ratio Shoulder to Jaw
No.	Kg			Mass g	No. Cysts	Cysts/ 100 g	Mass g	No. Cysts	Cysts/ 100 g	Mass g	No. Cysts	Cysts/ 100 g	Mass g	No. Cysts	Cysts/ 100g		
5 160	40	400 000	111	703,7	40	5	703,6	35	4,9	157	12	7	156,5	8	5	5,6	1,2
5 165	48.6	500 000	116	902,1	68	7	918,4	68	7	152	30	20	156,7	32	20	4,5	2,9
5 164	38.6	300 000	126	718	144	20	697,2	156	20	162,5	20	10	155,8	32	20	17,5	0,75
5 158	53,1	800 000	131	1 030	35	3	1 031,1	38	3	210	3	1	216,1	5	2	2,2	0,5
5 163	23	1 500 000	77	528,1	500	94	526	484	92	68,5	106	152	68,6	110	161	129,5	1,7

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AANTEKENING NOTE

ISOLASIE VAN *LEPTOSPIRA CANICOLA* BY VARKE EN HONDE IN SUID-AFRIKA

W. J. J. VAN RENSBURG*

SUMMARY

The occurrence of infection by *L. canicola* Utrecht Hond V in pigs is recorded for the first time in South Africa. Abortions, high perinatal mortality and low survival rate at weaning, as well as hypogalactia, infertility and irregular oestrus in sows were observed. Of 240 serum samples, 149 reacted positively to *L. canicola* with titres varying between 1/100 to 1/10 000. *L. canicola* was isolated from the kidneys in six of the ten pigs slaughtered.

In dogs, emaciation, high fever, anaemia and nephritis were noticed. Thirty-two out of 37 serum samples reacted positively in the same range of titres. In one dog that died, *L. canicola* was isolated from the kidneys.

Although the sources of infection could not be established, hygiene in all cases was poor.

'n Vlaag van aborsies, doodgebore kleintjies, melkremming en onvrugbaarheid, lae oorlewingsyfers by speenouderdom en hoë mortaliteit onder klein varkies het aanleiding gegee tot 'n ondersoek by 'n varkkudde in die Stellenbosch-distrik. Terselfdertyd het vrektes onder 'n trop jaghonde op 'n plaas in die distrik Caledon, met simptome van vermaering, hoë koors, bloedarmoede en nadoodse tekens van nefritis ook 'n ondersoek genoodsaak.

Bloedmonsters van 240 varke en 37 honde is sonder preserveermiddel geneem en die serum vir die mikroskopiese donkerveld-agglutinasie toets gebruik, terwyl van die niere van 10 geslagte varke en een hond, wat dood is, kwekings binne twee uur na dood op Korthoff se medium met toevoeging van fluouracil (250 µg/ml) by 27°C bebroei is.

Van die 240 varksera het 149 positief gereageer teen *L. canicola*, met titers tussen 1/100 tot 1/10 000. Uit ses van die varkniere is leptospira geisoleer en as *L. canicola* geïdentifiseer. Van gevestigde kwekings is die organismes deur die WHO/FAO se verwysingslaboratorium in Washington as *L. canicola* Utrecht Hond V getipeer.

Wat die honde betref is 32 van die 37 sera positief bevind teen *L. canicola* met titers wat van 1/100 1/10 000 gewissel het. Slegs een hond se niere is ondersoek en *L. canicola* daaruit geïsoleer.

In Suid-Afrika is *L. canicola* in 1953 by honde deur Malherbe en Kaschula serologies vasgestel [5]. Gear en medewerkers het in 1958 serologies positiewe resultate by rotte gevind [2], terwyl Beyers in 1965 agglutinasie titers teen *L. canicola* en *L. icterohaemorrhagiae* in 54 van die 100 honde vasgestel het [1]. *L. pomona*-besmetting is in 1965 serologies vasgestel by 'n varktrop in die Durbanville-distrik [4]. Na bovermelde ondersoek het Waner in 1972 *L. icterohaemorrhagiae*-besmettings by honde in die Woodstock-streek van Kaastad gevind, wat by die Stellenbosch-ondersoeksentrum as sodanig geïdentifiseer is. Die aandag word nou gevestig op die voorkoms van *L. canicola* onder varke in Suid-Afrika, waaroor daar voorasnog geen gepubliseerde verslae gelewer is nie.

In die geval onder bespreking is gevind dat, naas die bekende voorkoms van aborsie [3, 6, 7], melkremming en onreëlmatige bronstigheid ook 'n belangrike deel van die siektepatroon uitmaak, soos McErlean [6] ook waargeneem het.

Die oorsprong van die Leptospira-besmetting kon nie in die onderhawige gevalle vasgestel word nie. Daar was direkte kontak, swak higiëne en swak beplande hokke op albei plase, wat tot verspreiding van die organisme onder die diere bygedra het.

*Veterinêre Streekslaboratorium, Stellenbosch.

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INFORMATION — INLIGTING

A PILOT PLAN FOR THE CONTROL OF FOOT AND MOUTH DISEASE

The department of Hipolito Irigoyen in the Province of Buenos Aires has been selected for a government-sponsored pilot study on ways of controlling foot and mouth. The plan has been set up for three years and has the objective of determining the effectiveness of strictly enforced vaccinations coupled with good management practices that could then be applied on a larger scale to the whole country. The area covers 166 330 ha that has 183 047 head of livestock, consisting of 76 406 breeding cattle and calves; 68 617 steers; 21 207 sheep; 16 768 pigs and 54 goats. There are 453 farms in the zone; they were selected because of the diversity in the species of livestock carried.

The plan is under the direction of a veterinarian who has 4 other subordinate veterinarians to assist him as well as 14 technicians. This team will perform all the vaccinations in the area which will be conducted every three months on all cattle, sheep and pigs. All animals that are shipped into the zone must be transported on disinfected lorries. Livestock may be transported through the zone by lorry or railway car, but may not be driven through on foot. The producer may buy any vaccine that is currently available on the market but the order must go through the supervisors who will obtain it directly from the manufacturers, so that they can keep strict control on records of the types of vaccines used and their effectiveness.

If an outbreak occurs, the producer should immediately inform the authorities entrusted with managing the plan who will then take the necessary measures to ensure that the disease spreads no further. A small laboratory will be set up in the area so as to aid in identifying the type of foot and mouth variety that might develop and to assist in performing on the spot analysis. The technicians and veterinarians involved in the plan are expected to check each paddock under their jurisdiction once every 15 days. In the case of an oubreak the animals in the imminent zone will be quarantined for 30 days after the last animal has been cured.

La Nacion. December 16th, 1972. Agricultural Report No. 3, Agricultural Counsellor, South African Embassy, Marcelo T. de Alvear 590, Buenos Aires, Agentina. Published by the Department of Agricultural Technical Services, Pretoria.

Jl S. Afr. vet. Ass. 44 (4) : 437—439 1973

TECHNICAL NOTE · TEGNIESE AANTEKENING

MODIFICATION AND USE OF THE GENERATOR TYPE OF ELECTRO-EJACULATOR FOR RAMS

E. M. VAN TONDER, T. F. W. BOLTON, A. O. ROBERTSON AND L. GREEFF

SUMMARY

Improvements to the generator type of electro-ejaculator devised by Van Rensburg & De Vos [2] are described and specifications are given for the construction of an inexpensive, sturdy, easily made and smoothly finishde bipolar electrode.

Introduction

Experience with the generator type of electro-ejaculator devised by Van Rensburg & De Vos [2] have led to improvements, rendering it more suitable for field work, and to simpler and cheaper construction of a more durable bipolar electrode, which can be finished off to an even and smooth surface, which is not possible with the electrodes described by Edgar, Inkster & McDiarmid, [1] or by Van Rensburg & De Vos [2].

Apparatus

In our apparatus the emery wheel itself is replaced by a smaller, stout, rubber wheel, 9 cm in diameter and 1,8 cm wide. One of the two leads is attached to the generator and the other is earthed on any part of the apparatus. The wheel and generator are mounted in a wooden box, so constructed that it can also be used as a portable stool by the operator (Fig. 1). By extending the shaft on to which the handle is fixed, the entire apparatus can be concealed underneath the stool with only the handle protruding at the side (Fig. 1).

Besides ease of handling and transportation, the generator has a solid purchase when the operator sits on the stool. The equipment can thus be carried to any suitable spot and can be moved close to the animal. One operator can handle the complete apparatus and can control the application of the electric current. This facilitates proper stimulation with resultant satisfactory ejaculation.

The bipolar electrode (Fig. 2) is constructed from copper tubing, 200 mm long, of approximately 8 to 10 mm internal and 10 to 13 mm external diameter. A brass rod, commonly used for brazing, 350 mm long and 5 mm in diameter, and threaded at both ends, is screwed at the one end into a brass tip (the terminal electrode) 25 mm long and 10 to 13 mm in diameter, passed through an insulator 15 mm long and 10 to 13 mm in diameter, through the copper tubing and and handle, and screwed tight with the aid of a big brass washer and a brass nut at the other end. The insulator in this instance consists of a series of perspex rings fused together with the aid chloroform, while a suitable length of rubber or plastic casing, normally found as external cover and insulation for electric cords, is used to afford a firm fit of the rod into the copper tubing and to ensure proper insulation between these structures. The wooden handle, which should be approximately 115 mm in length and of any convenient diameter, should be provided with a central hole which will only allow the brass rod to pass through, as well as a smaller hole parallel to it, for one of the leads coming from the ejaculator to pass through. Immediately on emergence at the anterior end of the handle, this lead is soldered on to the copper tubing, which constitutes the posterior electrode. The end of the copper tubing which presses against the anterior end of the handle, around the central hole, is serrated so that it presses firmly into the wood when the nut at the posterior end of the rod is screwed tight. The other lead is firmly attached to the brass rod by means of an eyelet situated between the washer and nut. With proper finishing, the brass tip, perspex insulator and copper tubing form a solid probe with a smooth and even surface.

Method of Collection

The ram is restrained on its left side, assistants holding the head, front and hind legs respectively in such a way that the animal is not stretched. The penis is extruded by the usual method. Should difficulty be experienced, the ram can be lifted to the sitting position, the penis extruded and grasped with the right hand before the

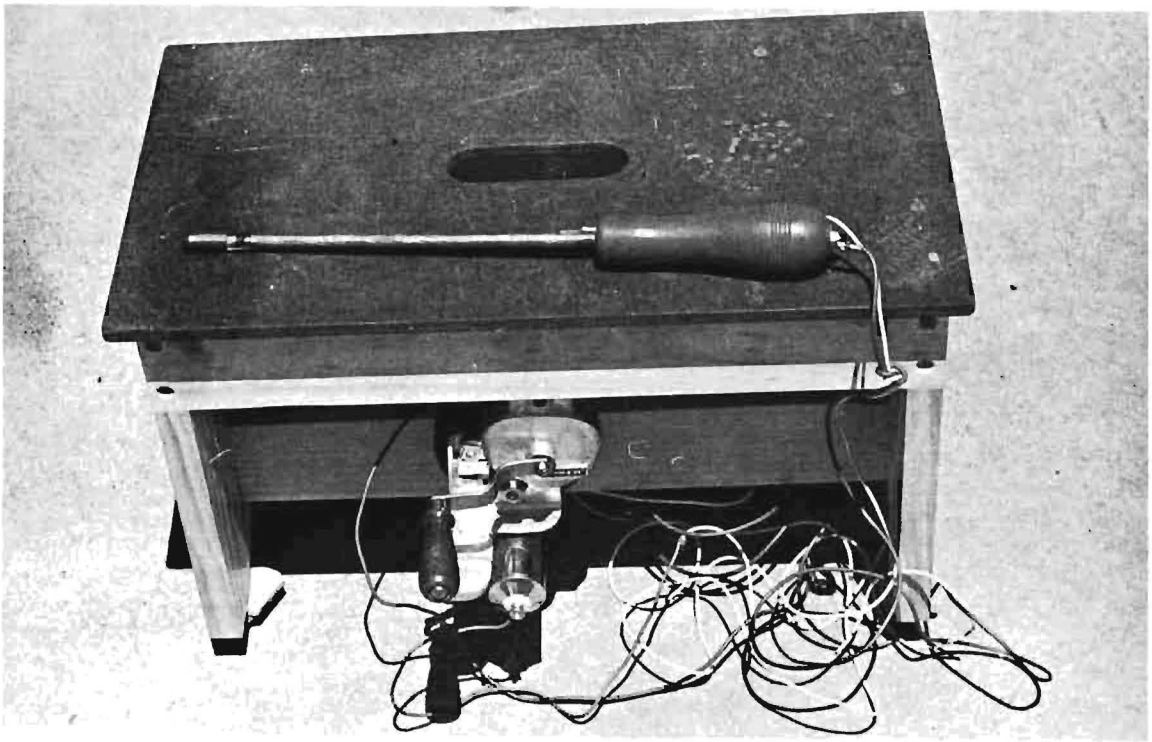

Fig. 1: Portable generator type electro-ejaculator.

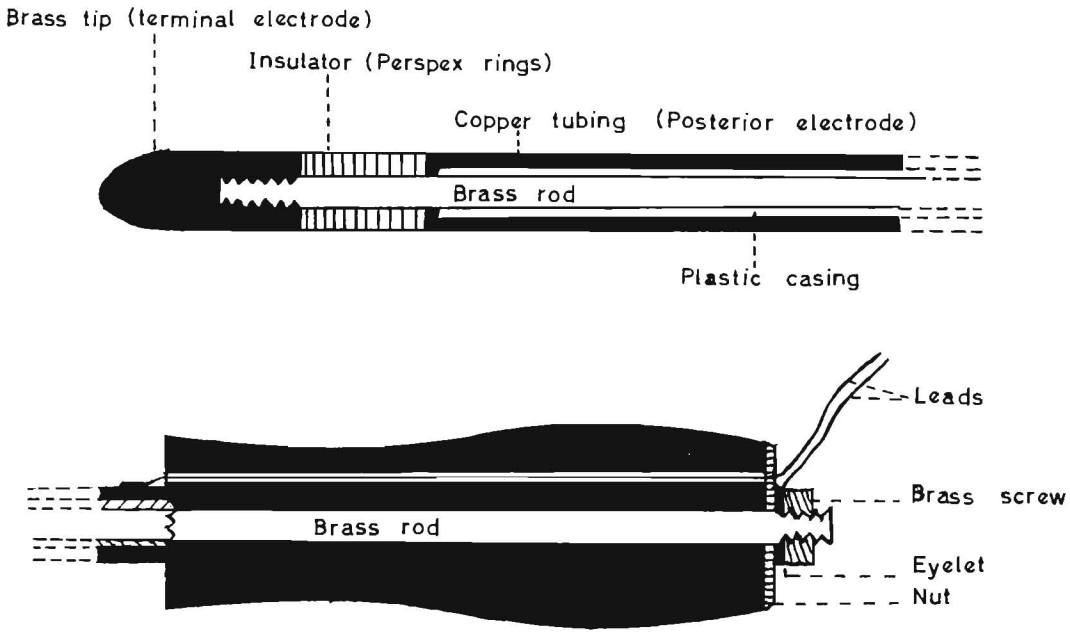

Fig. 2: Detail of construction of bipolar electrode.

animal is lowered on to its left side again.

A piece of ordinary bandage is folded in a tape ± 1 to 2 cm wide and placed in a loop around the penis, well behind the *collum glandis*. The person collecting the semen pulls the loop of the tape tight around the penis by holding the two ends close together by the palm and last three fingers of the left hand. By pressing the two sides of the loop together with thumb and forefinger of the same hand immediately below the ventral aspect of the penis, opposite the urethra, a firm grip on the tape and penis is secured. Immediately before ejaculation takes place, the tip of the penis, particularly the urethral process, is introduced into the container and the pressure on the tape and urethra is released. A wide-mouth McCartney bottle is preferred for the collection of semen since, apart from other advantages, it can easily be kept at the correct temperature.

The operator of the electro-ejaculator in the meanwhile has lubricated and inserted the bipolar electrode into the rectum for a distance of approximately 12 to 15 cm. Pressure on the handle should be exerted in such a way as to bring the inserted end in apposition with the ventral wall of the rectum overlying the *glandulae seminales* and the *ampullae*.

When the collector is ready, the handle of the ejaculator is turned, starting very slowly and gradually working up to a climax within the scope of 6 to 10 revolutions. At this stage the process is abruptly stopped for a few seconds while the electrode is moved around in the rectum. When the electrode is fixed at the correct site again a short sharp turn of the handle is given. This is usually followed by spontaneous and satisactory ejaculation.

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Authors' addresses: E.M. van Tonder & T.F.W. Bolton, Regional veterinary Investigation Centre, Middelburg, Cape 5900. A.O. Robertson & L. Greeff, Division of Agricultural Engineering Middelburg, Cape 5900.

BOOK NEWS — BOEKNUUS

AVIAN ANATOMY - INTEGUMENT

ALFRED M. LUCAS AND PETER R. STETTENHEIM

Agricultural Handbook 362 (1972), 750 pp., 422 illus. (all original except 3), lined, half-toned and colour; page size $9 \times 11\frac{3}{4}$, hard cover, Part I and II.

The skin and integumentary appendages are presented first at the gross, then at the subgross, and finally at the microscopic level, chiefly for the domestic birds—chicken, turkey, coturnix, duck, and pigeon, with frequent references to wild birds. New terminology has been introduced in both gross and histological areas because some structures described were unnamed or older terminology was inappropriate.

The book was prepared as a detailed reference source to meet the needs of poultry scientists, veterinary anatomists, histologists, physiologists, pathologists, diagnosticians, comparative anatomists, zoologists, ornithologists, and all other research investigators who use the bird, wild or domestic, as a laboratory animal. It will serve also the needs of the teacher for facts and illustrations.

FOR SALE BY: Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price: *$13.00* per set in the United States, its possessions, Canada, Mexico, and all Central and South American countries, except as hereinafter noted; *$16.25* per set for shipment to all other foreign countries, including Argentina, Brazil, British and French Guiana, Surinam (Dutch Guiana), and British Honduras. Remittance from foreign countries should be made by international money order or draft on an American bank, payable to the Superintendent of Documents.

Jl. S. Afr. vet Ass. 44 (4) : 441—442 1973

REDAKSIONELE AANTEKENING

DIE SUID-AFRIKAANSE ONTWIKKELINGSKORPORASIE VIR UITVINDINGS*

Die Suid-Afrikaanse Ontwikkelingskorporasie vir Uitvindings is 'n onafhanklike staatskorporsaie wat kragtens die Wet op die Ontwikkeling van Uitvindings (nr. 31 van 1962) op 8 Augustus 1962 opgerig is om in die nasionale belang verdienstelike ontdekkings en uitvindings te eksploiteer.

Die hoofdoel van die Korporasie is om as skakel op te tree tussen die uitvinding en sy uiteindelike toepassing en sodoende 'n bydrae te lewer tot die beter benutting van die vrugte van navorsing in die land. Die beheer oor die Korporasie berus by 'n Raad van Direkteure wat die belange van navorsingsinstansies en die nywerheid verteenwoordig. Die huidige Voorsitter is dr C. van der Merwe Brink en die Adjunk-voorsitter is dr F. J. Hewitt.

Baie van die uitvindings wat die Korporasie hanteer, het hul oorsprong by statutêre navorsingsinstansies. Daar bestaan dan ook ooreenkomste met verskillende navorsingsinstansies soos die Mediese Navorsingsraad, die Raad op Atoomkrag, die Nasionele Instituut vir Metallurgie, die WNNR en andere, waarvolgens die Korporasie die regte op hulle uitvindings op sekere voorwaardes mag bekom, indien dit blyk dat sulke uitvindings voldoende potensiaal inhou. Met die oog op eksploitasie, aanvaar die Korporasie ook uitvindings wat deur universiteite, private uitvinders en selfs firmas, wat ongeneë mag wees om self die koste aan te gaan, voorgelê word. In sulke gevalle word oor tantièmedeling ooreengekom.

Voorstelle wat vertroulik aan die Korporasie voorgelê word, word ondersoek ten einde die oorspronklikheid en tegnoekonomiese meriete daarvan te bepaal. Indien 'n voorstel aanvaar word, onderneem

*Inligting goedgunstiglik verskaf deur dr S. H. Eggers, Assistent-bestuurder van die Korporasie en deels verkry uit die Tiende Jaarverslag aan Aandeelhouers.

EDITORIAL NOTE

THE SOUTH AFRICAN INVENTIONS DEVELOPMENT CORPORATION*

The South African Inventions Development Corporation is an independent State Corporation, established in terms of the Inventions Development Act (No. 31 of 1962) on 8th August, 1972, to exploit, in national interest, inventions and discoveries of merit.

The main purpose of the Corporation is to act as a bridge between the invention and its eventual application, thereby contributing to the better use of the results of research in the country. The control of the Corporation is vested in a Board of Directors representing the interests of research and industry. The present Chairman is Dr C. van der Merwe Brink and the Deputy Chairman is Dr F. J. Hewitt.

Many of the inventions handled by the Corporation originate from statutory research establishments. Agreements exist, therefore, with various research bodies, such as the Medical Research Council, the Atomic Energy Board, the National Metallurgical Institute, the CSIR and others, whereby the Corporation may acquire the rights on their inventions on certain conditions, should it appear that such inventions have sufficient potential merit. With a view to exploitation, the Corporation also accepts inventions submitted by universities and private inventors, and even firms who do not wish to enter into the costs involved. In such cases agreements are entered into concerning division of royalties.

Propositions submitted confidentially to the Corporation are evaluated with regard to their originality and techno-economic merit. If a proposition is accepted, the Corporation undertakes and finances a patenting programme. Where necessary, the Corpora-

*Information kindly supplied by Dr S. H. Eggers, Assistant-Director of the Corporation and partially obtained from the Tenth Annual Report to Shareholders.

en finansieer die Korporasie 'n patenteprogram. Waar nodig, finansieer die Korporasie verdere ontwikkelingswerk ten opsigte van 'n belowende idee, en dit word dan ook dikwels as 'n gesamentlike onderneming aangepak waarvoor geskikte kontraktuele reëlings getref word. Die Korporasie onderneem geen vervaardiging nie, maar probeer kommersiële eksploitasie bewerkstellig deur met nywerhede lisensiëringsooreenkomste aan te gaan.

Die Korporasie tree op as agent vir navorsingsorganisasies, universiteite en private uitvinders en stel sy regs- en kommersiële kundigheid en finansiële bronne beskikbaar om belowende idees te ontwikkel tot 'n stadium waar nywerhede met realistiese voorstelle genader kan word. Van die kant van die vervaardigingsnywerheid kan die Korporasie gesien word as 'n bron van tegnologies gevorderde, nuwe vervaardigings moontlikhede.

Patentaansoeke van buitelandse firmas word voortdurend geëvalueer om te bepaal of hulle aansprake grondig is en of hulle ons ontwerpvryheid in die toekoms moontlik aan bande sal lê. Gedurende die huidige (10de) verslagjaar is 81 voorstelle ondersoek, maar slegs 13 was die moeite werd om te aanvaar. In dieselde tydperk is 7 uitvindings wat voorheen gepatenteer was, laat vaar as onlisensieerbaar en op 29 Februarie 1972 was die Korporasie met altesaam 63 projekte besig.

Geen jaarlikse toekening word van die Staat ontvang nie. Die Korporasie moet derhalwe soos 'n sakeonderneming fungeer deur sy uitgawe te dek uit die tantièmes en ander gelde wat met suksesvolle uitvindings verdien word. Terwyl van die Korporasie verwag word om selfonderhoudend te wees, word enige opbrengs wat deur suksesvolle uitvindings verdien word, teruggeploeg in die ondersteuning van nuwe projekte. Tegelykertyd word gepoog om sover moontlik daarvoor te sorg dat die uitvinder, sowel as sy instituut, waar van toepassing, hulle regmatige aandeel van enige winste behou. Oor die afgelope tien jaar het die inkomste uit tantièmes meer as R1,1 miljoen bedra, wat die bedryfsuitgawe, met inbegrip van betalings aan uitvinders, asook belegging in patente en ontwikkeling, oorskry het. Daar word nou alternatiewe metodes vir die finansiëring van die Korporasie oorweeg om die uitbreiding van sy werksaamhede moontlik te maak.

tion finances further development work required by a promising idea. Often this is undertaken as a joint project for which the requisite contractual arrangements are made. The Corporation does not undertake any manufacturing, but attempts to obtain commercial exploitation by licensing agreements with various industries.

The Corporation acts as an agent for the research organizations, universities or private inventors, placing its legal and commercial ability and financial sources at their disposal to develop promising ideas to the stage at which industries may be approached with realistic proposals. For the manufacturing industry the Corporation acts as a source of new, technologically advanced possibilities. Foreign-filed patent applications are continuously evaluated to determine whether their claims are valid and whether they are likely to inhibit our future freedom of design. During the year under review 81 propositions were assessed but only 13 were found to be worth accepting. In the same period 7 inventions previously patented were abandoned as unlicensable, leaving a total of 63 projects administered by the Corporation on 29th February 1972.

No annual grant of funds is received from the State. The Corporation must, therefore, function as a business concern by covering its expenses from royalties and other money earned from successful inventions. Although the Corporation is expected to be financially self-supporting, any return earned by successful inventions is ploughed back to support new projects. At the same time attempts are made to ensure that the inventor, as well as his institute, retains a rightful share of any profits. During the past ten years income from royalties amounted to more than 1,1 million rand, which more than covered running expenses, payments to inventors, as well as investment in patents and development. Alternative methods of financing the Corporation are now being investigated to enable it to expand its activities.

LETTER TO THE EDITOR — AAN DIE REDAKSIE

MUCOSAL DISEASE

Sir, May I add my comment to the very interesting paper "Mucosal Disease in Southern Africa" (Theodoridis A., Boshoff S. E. T. & Botha M. J.) in the March issue of your journal.

The suggestion that muscosal disease has been repeatedly diagnosed in Botswana is somewhat misleading. Clinical mucosal disease is rare in Botswana and the disease has been diagnosed clinically and then confirmed serologically only twice [1]. Most of the samples from Botswana included in the survey by Theodoridis *et al.* were submitted from these two outbreaks.

The suggestion that the disease is widespread is nevertheless correct. The percentage incidence of neutralizing antibodies against mucosal disease virus was similar in the clinically affected herds and in randomly selected animals from "clean" herds. There were significant differences, however, in the incidence of high titres ($< 1 : 625$) between the affected and "clean" herds.

Unlike the situation in South Africa clinical mucosal disease in Botswana has not been seen under intensive conditions of cattle farming, but under extensive range conditions in the presence of severe stresses (poor nutritional plane, severe helminthiasis, trypanosomiasis).

I. H. Carmichael
Veterinary Research Laboratory,
Private Bag 35,
Gaborone,
Botswana.

REFERENCE

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LETTER TO THE EDITOR — BRIEF AAN DIE REDAKSIE

CORRECTION - EDITORIAL

Sir,

I must draw your attention to a serious error in your editorial of the recent Journal 44 (2) 107-114, on page 108, which states that "The first fully fledged private practitioner was a graduate of 1934 who settled in Johannesburg in 1936."

This is incorrect and I post you an extract from the *Jl S. Afr. vet. med. Ass.* 37 (2) 1966. From this extract it is clear that my late wife, nee Joan Morice, was the first woman graduate and the first South African trained veterinarian to enter private practice in 1928 and I, M. C. Robinson, was the second in 1930.

I take a sad view of the serious lack of knowledge displayed by the Editor, and also members of some of the editorial committee who know me and knew Joan Morice well.

We were fully fledged veterinarians in 1927 and 1928. I will be extremely grateful if you will correct this serious omission.

Dr. M. C. Robinson,
9 Edinburgh Street,
Umkomaas.

We duly apologize for the wrong impression created The term 'fully fledged' was meant to convey that the Onderstepoort graduate had spent at least the greater part of his career in private practice and had been solely dependent on such a practice for income.

This letter and explanation will obviate further misinterpretation. It is time that someone interests himself in the early history of private practice in South Africa. Any volunteers? Editor.

GROWTH STIMULANT FOR CATTLE

A commercial form of anabolic steroid has been launched by Hoechst for use on fattening cattle. The manufacturers claim that by promoting better feed conversion, the weight gain over the 60 days before slaughter will be increased by an average of 30 lb. As well as the removal of detectable residues, they claim improved carcass quality, especially in the steak areas, and a greater killing-out percentage.

The firm calculates that, with live cattle fetching £19,50 a cwt, an extra net profit of £7,20—accounted for by better gain and better killing out—can be achieved on a 10 cwt animal.

The product was originally developed in France in 1957 by Roussel, a company in which the firm has a share interest. The steroids have been made into the compound trienbolone acetate, which is commonly used by athletes and body-builders for improving muscle condition and performance.

An injectable form which gives immediate results has been used for several years for restoring condition in convalescent animals and for treating the metabolic disorders of ketosis in cattle and pregnancy toxaemia in sheep.

Now a longer-acting form of the compound has been made up as pellets for growth stimulus, taking advantage of the steroid's ability to retain more nitrogen from feed for conversion to protein. The small pellets are administered under veterinary supervision in a 300 mg dose to any fattening animal—steer, heifer or cull cow—in the form of an implantation in the subcutaneous tissue at the base of the ear.

Each implant costs £1,20 and has to be given at least 60 days before slaughter.

The increased protein retention shows itself in better liveweight gains for the same amount of feed. Obviously this gain varies between different types of animal and management but in the firm's trials under farm conditions, gains ranged from 0,3 lb to 0,88 lb a day more than in the control animals. From this an average 0,5 lb a day is taken to back the claim of 30 lb more weight after 60 days.

The trials covered various management systems and table 1 summarizes the gains made as a percentage improvement over the controls. The weight gains of the controls serve to give some idea of the plane of nutrition of each trial.

The improvement in feed conversion is difficult to measure on systems where intake is impossible to assess, but it seems the more intensive the feed use the less the improvement in conversion.

It was found that under intensive barley beef production, with an ad lib ration of home-grown barley and urea supplement, the results in *table 2* were obtained.

Under yarded conditions, where the ration was restricted to 14 lb a day, a far greater improvement was obtained as the results in *table 3* show.

At slaughter, implanted animals showed a leaner, meatier carcass because of the improved protein conversion and also because of steroid action in repressing fat production for at least the first 30 days of the treatment *(table 4)*.

Dr Best, who has conducted most of the trials, said it is best on the implant system to aim for a heavier beast at the same age rather than shortening the fattening period.

"There is a good reason for this," he said.

Table 1: HOW IMPLANTED CATTLE PUT ON BEEF

		Number of animals	Sex	Period days	Implant Improvement over control		
					Control wt. gain lb./day	lb./day	%
I	Semi-intensive	16	Steers	56	1,35	0,82	+60,7
II	Semi-intensive	16	Steers	70	1,22	0,41	+33,6
III	Semi-intensive	16	Steers	63	1,29	0,30	+23,2
IV	Intensive	16	Steers	61	2,20	0,46	+20,9
V	Semi-intensive	22	Steers	56	1,18	0,88	+74
VI	Intensive	16	Steers	56	3,05	0,33	+11
VII	Semi-intensive	18	Heifers	56	1,42	0,31	+21,8
VIII	Grassland	48	Heifers	58	1,62	0,61	+37,6
IX	Grassland	18	Heifers	58	1,18	0,35	+23
X	Grassland	21	Steers	60	2,17	0,30	+13,9

Table 2:	Implant	Control
No. of animals	8	8
Daily gain (lb)	3,38	3,05
Feed per lb. gain (lb)	7,66 (−9%)	8,42

Table 3:		
No. of animals	8	8
Daily gain (lb)	2,66	2,20
Feed per lb gain (lb)	5,25(−23,4%)	6,48

Table 4:

Steers		
No. of animals	Implant	Control
Dressed weight per cent	8	8
Heifers	53,96 + 1,26%	52,70
No. of animals	9	9
Dressed weight per cent	54,81 + 2,14%	52,67

Richard Trow-Smith, **British "Farmers Weekly"**, February 23, 1973. **Landhou-rapport**, Nr. 111, Agricultural Counsellor (Scientific), South African Embassy, Trafalgar Square, London, W.C. 2N5DP. Published by the Department of Agricultural Technical Services, **Pretoria).**

"A heavier beast will not be fatter but it will be meatier. If it is killed at the same age as un-implanted animals the extra muscle will give an improved conformation on the hoof".

Dr. Best has found that barley-beef animals should be slaughtered promptly on reaching 60 days after implanting. "After 30 days the fat repression factor has worn off and after 60 days the protein retention has also worn off. It leaves the animals with an increased appetite which, if they are on an ad lib diet, means they will go to fat," he said.

The French had worked on cull cows to deal with the problem of animals putting on fat rather than meat when being fed for fattening. The trials had shown at least a 50 per cent improvement in gain; 30 per cent less feed was needed to produce a pound of meat and fatty deposits were decreased.

ANIMAL HEALTH AND PREVENTIVE MEDICINE *

An important development at Britain's National Agricultural Centre (NAC) at Stoneleigh in the English midlands has been the establishment of a multi-disciplinary team of the governmental Agricultural Development and Advisory Service (ADAS).

The ADAS team, comprising specialists in animal husbandry, agronomy, farm buildings, mechanization and drainage, and land use and conservation, has two major tasks: to help the NAC achieve high standards in its demonstration and exhibition work, and to use and develop the opportunities offered for advisory and extension activities.

The NAC — headquarters of the Royal Agricultural Society of England (RASE) and the permanent site of the Royal Show — provides a comprehensive information service for both British and overseas' farmers and has permanent livestock demonstration units with a staff of instructors as well as technical units. There are also conference facilities for support groups, including commercial organizations, and the centre also provides the opportunity for exchanges of ideas between farmers, advisors, educationalists, research workers and those with commercial interests.

Time Lag

The NAC attempts to update the original object of the RASE, which is to unite practice with science. There has always been a time lag between successful research and the adoption of its results. As in most countries, there is a need for quick and wide dissemination of ideas and techniques which have been proved in practice and the aim of which is to increase the total productivity of the agricultural industry.

The setting up of the ADAS team in 1972 was a big step forward and, the Royal Show aside, its main activities are concerned with demonstrations, conferences and a continuous information service. To obtain such ends, the specialists must gain considerable experience outside the NAC and they regularly visit farms and research establishments and attend conferences.

The veterinary officer has a particularly interesting task, with work falling into five main categories. Within the NAC there is direct involvement with disease monitoring and with the production of demonstration material on veterinary matters. One of the most important aspects of the NAC veterinary officer's task is to utilize the livestock units in the demonstration of the principles of good animal health and preventative medicine. He also supports the other specialists in their extension work where there are veterinary implications.

Outside the confines of the NAC the veterinarian keeps up to date by visiting farms, veterinary schools and Agricultural Research Council establishments to obtain views on veterinary problems, both at research and farm levels.

For the success of these ideas close liaison is established with the managers of the units and with local and company veterinary surgeons.

Mastitis Control

At the Dairy Unit mastitis control is of great importance and a mastitis committee has been formed, comprising a dairy husbandry advisor, experts on mastitis research, the practising veterinary surgeon and the unit manager. The

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control programme closely follows the recommendations by the National Institute for Research in Dairying and includes regular examination for pathogens and undertaking cell counts and biochemical analysis of milk.

The basic design of the control scheme consists of dairy hygiene, teat dipping and the use of dry cow therapy. Results are demonstrated for the benefit of visiting farmers.

In the past year two metabolic profiles (comprehensive blood analysis) of the NAC dairy herd have been analysed and the resulting data and comments are available, together with a discussion of the situations in which such profiles could be used. There was a demonstration of these principles at the 1973 Royal Show.

The profitability of a dairy herd depends on a good calving index or open interval, that is, calved cows should become pregnant again in a relatively short period after they have calved to ensure the continuous flow of milk. An analysis of breeding data has been made on which action can be made to improve the calving index. The use of this system together with farm records was demonstrated at the Royal Show.

Continuous Exhibit

Plans are in hand to use the normal health procedures carried out at the Pig Unit for demonstration at the Royal Show. This will become a continuous exhibit for the future with data on specific topics used to promote the concept of animal health, taking into account economic factors and performance figures.

The 1973 exhibit included data on erysipelas vaccination, care of the sow and litter at the time of farrowing, and care of the young piglet, with special regard to weaning. A number of visual aids on castration, teeth clipping, tail docking and other procedures of modern pig husbandry was included. The security of pig farms to disease entry formed a further exhibit.

Virus pneumonia causes a considerable loss of revenue to Britain's pig industry and there are plans to assess the level of this disease in the two systems of management operating at the NAC Pig Unit. Data with economic loss estimates will be instructive and may be related to the system, to the buildings and to environmental conditions such as temperature, relative humidity and ventilation.

Aspects of preventative medicine at the NAC Sheep Unit have progressed well. Metabolic disease monitoring has been carried out as a mini-profile with a view to mounting a demonstration on hypocalcaemia, hypomagnesaemia and pregnancy toxaemia — three important diseases in Britain. A project has commenced to demonstrate parasite control in the grazing animal together with monitored data from pasture sampling for the presence of parasitic larvae.

The NAC Sheep Unit includes a flock of rare sheep such as the Norfolk Horn, Cotswold, Woodland White Face (Penistone) and Manx Loghtan, on which haemotological studies are being undertaken by the Cambridge School of Veterinary Medicine.

Bird Deaths Survey

A large project being carried out at the NAC Poultry Unit is a complete survey of the causes of death of birds dying in egg-laying batteries. This will be concluded at the end of the laying period in January 1974, data then having been collected on the type of cage, position of cage within the house and the breeding of the birds. An interim report will be available in 1973 but a final assessment will not be available until the Royal Show in 1974.

Calf/Beef Unit

One of the main projects in the Calf/Beef Unit is the testing of the blood of all calves for the level of antibodies obtained via the colostrum in cooperation with a veterinary investigation centre. Such samples are routinely tested for *Brucella abortus.*

Calves are carefully examined for disease and tested for performance and the material gathered will demonstrate the need for and benefits of adequate colostrum feeding of the young calf. At present a large number of calves has been processed in this manner and the data collected formed a large exhibit at the 1973 Royal Show.

Future activities at the Beef Unit will include the control of liver fluke, the monitoring of pastures for parasitic larvae and the correlation of such data with the use of anthelmintic preparations for internal worms. A recent development has been the introduction of a system of metabolic profile assessment within the various beef systems at the unit and to relate this information to the production levels of the cattle.

Disease monitoring and control is a continuous process at the National Agricultural Centre and each successive Royal Show will exhibit additional material to help visiting farmers gain control of those diseases that cause them such great financial loss.

POWERFUL NEW ALLY AGAINST VIRUS DISEASE

A new antiviral drug, BRL 5907, has been perfected at the Beecham Research Laboratories in Surrey, England. It is a byproduct of penicillin, a double-stranded ribonucleic acid (dsRNA). Highly purified RNAs, freed from all trace of protein and DNA have been used before to stimulate interferon — the first mechanism of the body as a defence against illness — but their prophylactic powers have never before been demonstrated on such a dramatic scale and have previously only been used on laboratory animals.

At the Animal Virus Research Institute (AVRI) at Pirbright, southern England both pigs and cattle have been subjected to challenge by foot and mouth virus after treatment with the drug, with significant results. Groups of pigs and calves were inoculated with BRL 5907 either under the skin or into the peritoneum and then, together with untreated animals, were challenged by animals previously infected with the "C Noville" strain of the foot and mouth disease virus. While all the controls caught the disease and exhibited symptoms almost immediately, 85% of the treated pigs appeared to be immune and the 15% balance showed substantially delayed symptoms.

With calves the results were not so conclusive. Only 25% showed immunity but once again the appearance of lesions on the feet and mouth were delayed. These blisters are the main source of infection spread. Antibodies were found in the animals that did not develop lesions and this indicates that the dsRNA did not prevent virus multiplication at the primary site of infection but did prevent dissemination to the feet and mouth.

The failure of calves to react to the drug as strongly as pigs, may be because of the larger amount of infective virus required to cause the disease in cattle compared with pigs. Calves on test were therefore subject to a much greater challenge of FMD. This theory will be tested through the experiments that are continuing.

The presence of detectable interferon did not appear to be necessary in the treatment with BRL 5907 and interferon production may be only an indication of stimulation of a system and protection may be by other means.

Nevertheless, the principle that viral infection can be opposed by drugs has now been proved.

One of the most important aspects of the discovery lies in the drug's apparent effectiveness with pigs exposed to the disease. Highly efficient vaccines have already been produced at Pirbright for protecting cattle against foot and mouth disease but they have not, however, proved as effective with pigs unless given at high dosage rates — which are uneconomic — or with the addition of an oily adjuvant which tends to cause swellings and other irritant local reactions. The new drug may provide a far more efficient prophylactic against foot and mouth disease in pigs. It will prove of value with all species as a treatment that can be used when a new sub-strain appears.

The new drug has also been tried out as a protection against other vesicular diseases and, so far, has led to a delay of symptoms in rodents infected with vesicular stomatitis and pigs infected with swine vesicular disease.

In the interim, however, the first commercial vaccine against swine vesicular disease has been perfected. The disease is now believed to be far more widespread than was at first thought — particularly in areas where foot and mouth disease is prevalent. Swine vesicular disease has probably been mistakenly diagnosed as foot and mouth disease and the new Pirbright vaccine is likely to make a major impact on future control.

A slaughter policy will be continued in Britain should further outbreaks of swine vesicular disease occur and a similar policy will be followed in the event of foot and mouth disease — of which there have been no cases since 1969.

Experimentation on the BRL 5907 strain of RNA is at a very early stage. The product is not yet on the market but it is not expected that the cost will be greater than that for foot and mouth disease vaccine.

Research workers at Pirbright and the Beecham Laboratories are now engaged in efforts to improve the drug or its application to provide protection against other viruses in all species of livestock and also to reduce the number of doses now needed to achieve immunity in pigs. It is thought that eventually only one treatment will be necessary in the life of each pig.

The full significance of the discovery of BRL 5907 cannot be assessed at this stage. The contribution it will make in the control of foot and mouth disease is evident although it is prophylactic and not curative. Even more important than this particular product, however, is the fact that drugs have now been proved as possible allies in the battle against virus diseases of all types.

Adapted from an article by Bryan Platt in London Press Service No. 5032/3. Kindly supplied by the Press Officer, Information Section, British Consulate-General, Johannesburg.

THE HALF-MILE STETHOSCOPE

A research team consisting of D. P. Attenburrow, a Devon veterinary surgeon, and F. C. Flack of the Physics Department of the University of Exeter, has produced a specially developed audio vibration transducer which can be attached, without any resentment on the part of the animal, to a horse's neck so that it overlies the wall of the windpipe.* The transducer generates an electrical signal which varies according to the horse's breathing.

This signal is broadcast over a radio link up to 0,8 km in length to a receiver which permanently records it on tape. The tape recording can later be played back for repeated examination at leisure or put through a chart recorder to produce a visual representation of the sounds. Abnormalities may then be recognized and the particular part of the respiratory cycle with which they are associated can be identified.

Examination of data from a large number of horses has furnished typical graphic shapes for clinically normal subjects for the various paces. The duration of the sounds recorded during inspiration and expiration of the complete respiratory cycle can be measured to an accuracy of 1/100th of a second, as can the respiratory rate itself.

Measurements from the apparatus have shown that in a normal horse at a canter or gallop the timing of the events of respiration obey a mathematical law with a precision which seems remarkable in a living subject.

If the respiratory rate is multiplied by the duration of one period of breathing in, it gives a constant which has not varied by more than 3% in the subjects so far examined, whether they are 11 hands children's ponies or 17 hands racehorses. This constant is higher than the normal if the horse has an upper respiratory tract obstruction, lower if the animal has a pulmonary malfunction.

The team has also developed a separate transducer system to allow accurate measurement of the time for which the foot is on the ground and the time for which the foot is carried during all forms of exercise. By this means it has been demonstrated that at a canter and a gallop the respiratory cycle and the cycle of limb movement take place together within close time limits — that is, to plus or minus 1/50th of a second.

The "locking-on" of the limb cycle to the respiratory cycle has been demonstrated to occur at the first stride of the canter but it has not been possible to demonstrate any comparable relationship for horses at the walk or trot.

The team is anxious that too much importance should not be attached to its findings so far, as it is necessary to make respiratory and other observations on a large number of horses to establish the value of physical quantities which may be regarded as normal. The intended aim of the research is diagnosis by physical measurement, so that any horse demonstrating abnormal values must be regarded as potentially clinically abnormal although examination by the conventional means at present available does not necessarily indicate this.

This work may eventually place in the hands of the veterinary surgeon a method of assessing a horse's respiratory functions in a standard, completely reliable and objective manner, particularly as conditions at rest — which can easily be measured — do not necessarily prevail at exercises when some compensatory factors come into play.

A problem typical of the type it hopes eventually to solve is that posed by a "whistler" racehorse known to have been affected for at least seven years but which won 19 races, while another animal, judged by present methods to be in a similar condition, proved to be incapable of doing a full day's hunting.

An interesting byproduct of the "cycle of limb" movements test was thrown up when the team did a recording on El Farruco, Britain's leading Olympic dressage horse, and afterwards reproduced it in visual form before an audience of dressage judges. A different light was illuminated during the period of ground contact for each of the horse's feet. So graphic were the results that the audience was not only able to say which particular phase of the test the horse was performing but also where deviations of rhythm of movement were occurring.

Obviously it is not at this stage a judging tool which can be used in actual competition but it opens up interesting speculations as to whether it could develop into a useful training aid, whereby a rider can study his own and his horse's performance at leisure with a view to eliminating the faults.

* In the photograph supplied, the transducer is in position over the horse's nostril. ED.

Abbreviated from an article by Frank Barrett, London Press Service, No. 4815/3, kindly supplied by Mr. H. A. Oppel, Press Officer, Information Section, British Consulate-General, Johannesburg.

BEEF, A BASIC EXPORT PRODUCT OF LATIN AMERICA

In the past decade Latin America's export sales of meat and meat products grew from almost $300 million in 1961 to an estimated $700 million in 1970. In the same period sales of live cattle almost doubled, from $66 million in 1961 to $101 million in 1970. In spite of the impressive figures, however, the growth is not evenly distributed throughout the region, and in many places meat production is falling behind the annual rate of population increase. It is generally conceded that for meat production and exports to expand at an adequate rate in the future, it will be necessary to overcome a number of obstacles.

Although livestock is found in virtually every country of the world, most of the meat produced is consumed internally, so that only about 7 per cent of the total world output enters international trade. The United States, for instance, is the world's largest beef producer, but because of the high demand in that country, it is also the major importer.

Because meat is predominantly a product of the temperate zone, where grass and grains used as fodder for cattle grow in abundance, 90 per cent of Latin America's beef production is located in Argentina, Uruguay and the temperate zones of Brazil, Mexico and Colombia. European Herefords and Aberdeen Angus make up the bulk of the livestock in Argentina and Uruguay, but those breeds are not well adapted to the tropical areas of Latin America. Creole strains that have evolved over the years and certain crosses — with the Zebu (Brahman), for instance — show much more encouraging signs of success there.

Argentina is the undisputed giant in beef exports. It has led the countries of the world since 1905, and in 1969 registered export earnings of $433 million in sales of meat and meat products and $38 million in live cattle — roughly one fourth of its total export revenue. More than two thirds of all Latin America's beef exports come from Argentina; in 1969 the country exported 561 295 tons of beef.

The latest expansion of the beef industry in Argentina began in 1964, and by 1969 there were some 51,5 million head of cattle in the country — a cumulative increase of 5 per cent yearly. At the same time, its production of meat increased significantly, at an annual rate of 5,8 per cent.

About four-fifths of Argentina's cattle population is concentrated on the humid pampas, an area of some 113 million acres. Brazil has about the same amount of pastureland as Argentina, but the cattle population of that country is almost double Argentina's — approx. 100 million head, exceeded in the world only by the United States and the Soviet Union. Nevertheless, because of the wide differences in the efficiency of the livestock sector, Argentina's production is almost double that of Brazil.

Uruguay, with the highest rate of cattle per capita and per acre in Latin America, ranks second in the area and fourth in the world as a beef exporting nation. There have been no major long-term changes in its cattle inventory in the last half century.

Other countries of the region registering advances in meat production include Bolivia, Panama, Venezuela, Colombia, El Salvador, Nicaragua, Costa Rica and Paraguay. The latter three are now exporting significant amounts of meat and meat products.

Many problems in the evolution of the cattle industry in Latin America can be attributed to slow application of scientific and technological advances. Outmoded systems are still in use in many cattle zones, and there is need for progress in cattle reproduction rates, sanitary control, genetic improvement of the strains, better pasturelands and feeding practices, and generally speaking, in administrative methods.

Of special consequence is the problem of diseases and plagues, especially foot-and-mouth disease, which to a lesser or greater degree affects all the South American countries and constitutes a serious handicap to the expansion of the industry and to increasing exports of fresh, chilled and frozen beef and live cattle.

BEEF EXPORTS: LATIN AMERICA
(in million of U.S. Dollars.)

MEAT AND PRODUCTS	1960	1968	1969	1970
Agentina	219	335	433	438
Brazil	23	45	70	—
Costa Rica	3	12	15	—
Guatemala	---	9	11	13
México	16	36	42	—
Nicaragua	3	16	21	27
Paraguay	7	14	11	(E) 16
Uruguay	31	60	62	87

(E) = Estimated --- = Not available

Americas, monthly magazine published by the General Secretariat of the Organization of American States (OAS). Agricultural Report No 2. Agricultural Counsellor, South African Embassy, Marcelo T. de Alvear 590, Buenos Aires, Argentina. Published by the Department of Agricultural Services, Pretoria.

INFORMATION INLIGTING

FIRST VERIFICATION OF ATROPHIC RHINITIS INFECTION OF PIGS IN ARGENTINA

Atrophic rhinitis, first described in Germany in 1930, has been reported since then in various parts of the world, including Uruguay in 1960. There had been no documentation of its existence in Argentina prior to the report made by INTA researchers earlier this year (1972). Their report includes a detailed coverage of the symptoms, lesions and bacteriological survey in pigs that developed the disease while at PERGAMINO INTA Research Station. They infected piglets experimentally from those that had contracted the disease naturally in order to study the disease in more detail.

Their bacteriological survey of the nares of the infected animals suggested that a variety of organisms could be implicated as the causative agents and these included *Pseudomonas aeruginosa, Klebsiella, Bordetella bronchiseptica* and *Haemophilus.* The most consistent finding in the autopsied pigs 8 months after they had been experimentally infected was that the cribriform plate of the ethmoid bone was always inflamed even though the pig may have showed no outward signs of the disease. This led the authors to the presumption that sows could be undetected carriers of the infection, which they could then transmit to their offspring more easily than to older animals, as piglets are more susceptible to infection. This would explain why some reports in the literature attributed the disease to genetic factors. They emphasized that the disease should not be treated on an individual basis but that the whole herd should be attended to whenever an outbreak occurs.

(Revistas de Investigaciones Agropecuarias, Serie 4 - Vol IX: I, 1972 Agricultural Report No. 3, Agricultural Counsellor, South African Embassy, Marcelo T de Alvear 590, Buenos Aires, Argentina. Published by the Department of Agricultural Technical Services, Pretoria.)

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INFORMATION

INLIGTING

ROLICIN, A NEW ANTIBIOTIC ACTIVE ON GRAM-NEGATIVE BACTERIA

This antibiotic was purified from the leaves of ***Rollinia emarginata*** Schlecht, a tree that is quite common in Brazil, Paraguay and Argentina. The active ingredient of the leaves was obtained by soaking the leaves in alcohol (70%) at 40°C, and washing them with chloroform so that the material in the aqueous layer could then be further purified on a carbon celite column (1:1) by elution with a water alcohol gradient of 0-30% alcohol. A material of 80-90% purity was obtained which was soluble in water at neutral pH and which reacted strongly like carbohydrates and weakly like phenols. The material was found to lose its antimicrobial action on exposure to air but not when heated.

The strongest antibacterial activity was on *Xanthomonas, Erwinia, Brucella* and *Pseudomonas* organisms; a weaker activity on *Corynebacterium, Escherichia* and *Salmonella;* and a very weak activity on *Bacillus, Clostridium, Proteus, Sarcina, Serratia* and *Staphylococcus.* The bacteriostatic and bactericidal values determined on *Salmonella parathypi* was 32 *ug* and 64 *ug*/ml of rolicin, respectively. The authors comment that this high potency of the antibiotic at such low concentrations is unusual for antibiotics isolated from plant material.

Rolicin was also effective in inactivating foot and mouth virus *in vitro.* It was ineffective, however, when injected intraperitoneally into mice at a level of 10 *ug* a day, 24 hours before and for three successive days after the mice had received foot and mouth virus intramuscularly.

Intraperitoneal injections of various concentrations of rolicin into mice revealed that the LD_{50} determined by probit analysis was 1,14 g/kg. The authors emphasize that there is a very small margin between the sublethal and lethal dose. The mice that survived the toxic dose recovered rapidly after 4 hours after injection at which time the active material could be detected in the urine. The urinary excretion of rolicin continued for up to 8 hours after injection. No rolicin activity could be detected in the blood or faeces of the injected mice.

Revista de Investigaciones Agropecuarias - Serie 2 - Vol VIII, P.245 Agricultural Report No. 2, Agricultural Counsellor, South African Embassy, Marcelo T. de Alvear 590, Buenos Aires, Argentina. Published by the Department of Agicultural Technical Services, Pretoria.

TOTAL BAN ON DIETHYLSTILBESTROL

Livestock producers in the U.S.A. have just been deprived of one of their most powerful tools — the use of diethylstilbestrol (DES) implants, in terms of the recent decision by the Food and Drug Administration to ban the only remaining use of this synthetic growth hormone. Towards the end of 1972 the FDA banned the use of DES as an additive in feed, in compliance with the provisions of the "Delaney Clause", legislation which requires the testing of food by the "best method" existing, for residues of additives shown to be carcinogenic. The "best method" available at present is gas chromatography, by which quantities as minute as 0,5 parts per billion can be detected.

U.S. Secretary of Agriculture, Dr Earl S. Butz, despite his acknowledgement that the decision was "necessary" because of the Delaney Amendment, still holds the view that potential hazards surrounding the use of additives, pesticides, etc., should be weighed against the tremendous benefits which accrue as a result of their use, and points out that in this instance a product is involved which. "has been used for more efficient food production for twenty years with no known instance of harm to humans". Secretary Butz also points out that the action will result in increased food costs to the consumer. Although the precise extent of the economic impact of the ban is not known a previous study based on the use of DES as a feed additive showed that the banning thereof could cost consumers several hundred million dollars annually. It could increase beef prices paid by consumers by as much as $450 million a year, as it could result in an extra 35 days and approximately 226 kg of additional feed being required to fatten a steer for market. In most cases, growth stimulants will reduce feed cost per 45,3kg of gain, by $2 to $2.60. An animal gaining 226kg would therefore save a farmer $10.00 to $13.00, or enable him to feed 10% - 12% more cattle with no increase in feed, if growth stimulants are used. Additional advantages are that the added growth is muscle or meat, rather than fat.

Several other growth-promotants are currently in use in the U.S.A., having been approved some time ago. Whilst some of these may be more expensive than Diethylstilbestrol and in the case of implants may require reimplantation, they are apparently as effective, or nearly as effective, as DES in promoting growth. The U.S. Department of Agriculture holds the view that more extensive use of these alternatives may enable cattle breeders to cope with the ban on DES-implants without their having to raise the price of meat to any appreciable extent.

In an earlier report emanating from this office (Landbou-Rapport No. 46 of 4th August, 1972) several alternatives to DES were discussed. The status of all of these remains unchanged with the exception of "Rapigain" which is automatically banned because it contains a certain amount of DES. Of the alternatives currently approved for use, the following are the best known—

Synovex-H ®

Contains testosterone propionate and estradiol benzoate. 8 pellets equal a single dose of 200 mg testosterone propionate and 20 mg estradiol benzoate. Implant at least 60 days before slaughter. For heifers.

Synovex-S ®

Contains progesterone and estradiol benzoate. 8 pellets equal a single dose of 200 mg. progesterone and 20 mg. estradiol benzoate. Implant at least 60 days before slaughter. For steers.

Synovex-S and Synovex-H have been on the market for nearly as long as DES. In some research trials, these compounds have produced superior results to those obtained with DES, mainly as a result of their effect in stimulating gain for a longer period of time. Synovex-S or Synovex-H pellets are larger than DES but are still easy to implant. The compound comes in a plastic tube with one dose to each tube.

Ralgro ®

Brand of Zeranol [6,10-dihydroxyundecyl]-B-resorcylic acid-*u*-lactone; also known as RAL compounds.

Steers - 3 pellets, 36 mg.
Heifers - 3 pellets, 36 mg.
Nursing calves - 1 pellet, 12 mg.
Sheep - 1 pellet, 12 mg.
65-day withdrawal.
Commercial Solvents Corp. - implant.
This is an anabolic agent.

Ralgro (Zeranol) is the newest implant cleared for use. Response is stated to average approximately the same as that for DES but results may be more variable. Ralgro implants remain effective for 120 days, an added advantage being that animals may be slaughtered 65 days after receiving the implant.

Implanting is done in the back of the ear, by inserting the needle into the skin about 3,8cm from the head. When the needle has reached the point between the skin and the cartilage all that remains is for the trigger on the implant gun to be pulled. With proper handling equipment, two men can easily implant 60 head per hour. Without proper equipment, however, it is almost impossible to perform an implant.

In addition, although not quite comparable with the above, there is the feed additive:

MGA : Melengesterol acetate, for heifers. Steers do not respond

The USDA will continue to monitor residues of DES in carcasses coming to slaughter, the cattle having legally been implanted with DES before the ban had been imposed. If the continued monitoring programme shows that cattle feeders are complying with the ban, USDA will reduce the number of analyses and direct more attention to other residue problems.

Personal communication: Dr Donald Berreth, FDA Bureau of Veterinary Medicine, Rockville, Maryland; **NEWS - USDA Press Release** No. 1278-73 of April 25, 1973; **Memorandum:** Animal and Plant Health Inspection Service, Meat and Poultry Inspection Program, Washington, D.C. 20250, April 25, 1973.**Progressive Farmer,** November-December 1972. **Agricultural Report** Nos. 65, 81, Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Avenue, N.W., Washington D.C. 20008, USA. Published by the Department of Agricultural Technical Services, Pretoria.

NFORMATION INLIGTING

A "NEW" FORAGE GRASS FOR SOUTH AFRICA

The value of South African grasses is once again being appreciated by the Americans.

University of Arizona scientists report the recent release by the Soil Concervation Service, the Agricultural Research Service and their University, of 'Palar' Wilman lovegrass (*Eragrostis superba* Peyr), bred from foundation seed imported in 1963 for use in a nine-year evaluation programme.

'Palar', a superior natural selection of Wilman lovegrass — its name being derived from its palability characteristics — is extremely tolerant to drought, performing well from the point of view of stand establishment, in dry desert shrub zones (with summer rainfall of 100-150mm.

The variety is well adapted to the desert grasslands of the south-western parts of America, with 300-410mm of total precipitation at elevations below 1 341m, and moderately well adapted to the drier desert shrub areas where precipitation ranges from 250-300mm and has demonstrated superior performance in seedling establishment and forage yield when compared to the former commercial Wilman lovegrasses and other varieties. (It also yields good seed production when grown under irrigation). Average potential germination of Palar seed is approximately 89%, firm seed usually accounting for approximately 36% of the total live seed although it has been known to be as high as 67%.

The fact that seed of this grass is now commercially available for importation back into South Africa may be worthwhile exploring in the context of radical veld improvement, particularly when one bears in mind that it occurs naturally in the Northern Cape, Natal, the Orange Free State, the Transvaal, South West Africa and Botswana.

(Progressive Agriculture in Arizona, Vol. XXIV, No. 5 1972 **Agricultural Report** No. 67 Agricultural Counsellor (Scientific) Embassy of South Africa, 3051 Massachusetts Avenue, N.W., Washington D.C. 20008, USA. Published by the Department of Agricultural Technical Services, Pretoria.)

EXPERIMENTALLY INDUCED FOOT AND MOUTH IN SHEEP

But few experiments have been performed on foot and mouth disease in sheep because of the irregular macroscopic lesions that appear when the disease occurs naturally and even more so when experimentally induced. Previous workers showed that one fairly regular symptom in sheep was a streaming of a shiny, bright mucus from the nose.

The object of this experiment was to determine whether the virus could be detected in the nasal cavities of sheep experimentally infected with the virus. Three strains of bovine virus were used: 0_1 Caseros, A_{24} Cruzeiro and C Resende, whose respective ID $_{50}$ were $10^{8,8}$ /g, $10^{7,60}$ /g and $10^{7,90}$ /g.

Infection of the sheep was either by injecting the lower gum or the dorsal surface of the tongue and also by subcutaneous injections in the thigh.

The sheep treated with 0_1 Caseros virus had hyperthermia for several days after the injection with a peak temperature (41°C) at 72 hours after injection. The only other characteristic symptom that developed was the appearance of the nasal mucus that was observed 24 hours after injection.

A cotton gauze swab was used to collect mucus from the central nasal passage which was then transferred to a phosphate solution containing penicillin and streptomycin. Dilutions were made of these samples after centrifugation and these were then injected in to six six-day old suckling mice.

Mucus samples collected at 24, 48, 72 and 96 hours after injecting sheep in the lower gum with a 1/10 dilution of the 0_1 Caseros virus, killed all the mice, whereas a sample collected 7 days after the injection had no effect on them. Fixation tests on samples from the dead mice were all positive for virus 0.

Injecting a 1/10 000 dilution of the virus 0_1 Caseros produced similar results and subcutaneous injections in the thigh resulted in high titres (10^{7}) of the virus appearing in the collected mucus.

Two sheep were slaughtered 72 hours after infection via the tongue and samples were taken from the upper air passages, the trachea, the pharynx and the lungs. Greater titres were obtained from the upper air passages than from any of the other locations. The samples were washed carefully with the phosphate solution to ensure that the surrounding mucus was removed so that the virus activity detected could be attributed to the tissues *per se*.

The viruses C Resende and A_{24} Cruzeiro did not affect the sheep to the same degree as 0_1 Caseros. In both cases there was hyperthermia of short duration and the recorded titres of the virus from the mucus collected at 72 hour. never reached the high values obtained with the 0_1 Caseros; nor could they be detected for as long a period after the infection. The authors believe that the sheep is more resistant to those two strains of bovine virus so that only a mild infection occurred.

The depression and anorexia, so typical of foot and mouth disease, were never very severe in any of the infected sheep in spite of the hyperthermia.

The authors conclude *prima facie* that the virus disturbs the tissues of the upper air passages without causing any visible macroscopic lesions. They propose that the virus migrates to the upper air passages where it multiplies and then is spread in the exhaled air of the sheep. This suggests that the sheep is probably an important vector in spreading of the disease. They also state that their findings indicate that their techniques could be of value in developing and testing new foot and mouth disease vaccines.

Revista de Investigaciones Agropecuarias - Serie 4 - Vol. VIII (4) 109. Agricultural Report No. 2, Agricultural Counsellor, South African Embassy, Marcelo T. de Alvear 590, Buenos Aires, Argentina. Published by the Department of Agricultural Technical Services, Pretoria.

POULTRY GENETICS

Associate Professor Dr Ralph G. Somes, an animal geneticist in the Department of Nutritional Sciences, University of Connecticut produced the second edition of his "Registry of Specialized Genetic Stocks".

The first edition of his registry, the first publication of its kind ever published in the U.S.A., was released in the United States last year. This 53-page reference work is intended to inform scientists and others of the availability of chickens with specific genes or characteristics which can be used in various biological studies as well as proxies for humans. It is also designed to serve as a means of preserving genes which might otherwise become extinct, by acting as a source of communication through which their distribution might become more widespread.

The registry lists 87 specialized lines and strains, 103 mutant traits, and 260 breeds and varieties. Such mutant traits as muscular distrophy, diabetes, auto-immune thyroiditis, and uricemia and articular gout are but a few examples of the many specific genes that are listed.

Included in the second edition will be two additional species: the turkey and the Japanese Quail and also chickens, turkeys and Japanese Quail with specific genes from Canada. It is anticipated that this edition will be published in 1975.

Single copies of the first edition — "Gallus Domesticus; Registry of Genetic Stocks in the United States (Bulletin 420)" are available free-of-charge, on written request to: Agricultural Publications, University of Connecticut,

P.O. Box U-35,

STORRS, CONNECTICUT 06268

BIBLIOGRAPHIE SUR L'ÉLEVAGE DES RUMINANTS DOMESTIQUES EN AFRIQUE AU SUD DU SAHARA 1930-1969

Suivie de propositions de développement de l'économie animale

ODON DERAMEE

This work, published by CEDESA, Centre de Documentation Economique et Sociale Africaine (Centrum voor Afrikaanse Economische en Sociale Documentatie), 7 Pl. Royale, Bruxelles, Belgium, has just appeared. It forms fascicle XVI of CEDESA'S bibliographical investigations. It is drawn up according to the bilingual (French and English) analytical classification traditional for the Centre's publications.

In four volumes comprising XIV and 1 431 pages, 8 988 bibliographical references are listed under six sections:

1. Main causes of mediocre productivity
2. Intergovernmental action to realize pastoral potential (this includes veterinary planning, standardization of vaccines and sera and establishment of supply pools).
3. Definition of directives for a rational agro-pastoral policy.
4. Government and livestock industry (assistance and extension work).
5. Development of a sound and healthy livestock industry (including livestock improvement at various centres, with emphasis on breeding, alimentation, physiology and ecology).
6. Protection of animal health and campaigns against epizootic diseases.

The price is 3 000 Belgian franc, payable at the Banque Belgo - Congolaise, Account 46.201.

INTERNATIONAL EQUINE VETERINARY CONGRESS

The first International Equine Veterinary Congress will be held in the Kruger National Park (Game Reserve) in South Africa from the 4th to 10th August, 1974. Speakers are being invited from the United States of America, the United Kingdom, Germany, Sweden, Switzerland and Australia.

The two topics for discussion are:-

A. Some parameters indicative of performance ability and state of fitness in the race horse

B. A survey of the physiology, medicine and surgery of the alimentary tract of the horse.

This Conference is intended to draw together the knowledge and experience of Equine Veterinarians from all over the world.

Registration will be limited at this prestige meeting. This advice is being circularised for all those interested in attending or offering a paper to be able to plan well ahead.

The programmes will be prepared by November and those interested are requested to write to *Dr. M. A. J. Azzie, P.O. Box 4024, Alrode, 1541, South Africa* without delay. Veterinarians with new knowledge in these fields, please communicate with the convenor by submitting a summary immediately.

WORLD ASSOCIATION FOR BUIATRICS

VIIIth INTERNATIONAL MEETING ON DISEASES OF CATTLE MILAN / ITALY, 9—13 SEPTEMBER, 1974

The meeting is organized together with the VIth annual congress of the Italian Society on Diseases of Cattle.

Venue: Provincial Conference Hall, Via Corridoni 26

The general topics are:

1. The role of mycoplasma in bovine pathology
2. Genetic aspects of cattle breeding
3. Foot and leg diseases in modern breeding establishments
4. Metabolic diseases of cattle: diagnosis, therapy, and prophylaxis

Lectures of 20 - 30 minutes each are to be followed by coordinated short communications, lasting 10 minutes each.

The last day is reserved for "Free Subjects" on all aspects of diseases of cattle; films can also be presented.

Official languages are: Italian, French, English, German und Russian (Simultaneous translation)

An industrial and scientific exhibition will be set up.

Social events and excursions are scheduled for participants and attendant persons.

Registration fee

received till February 28th, 1974	Lir. 25.000,-
received till June 30th 1974	Lir. 30.000,-
received thereafter	Lir. 35.000,-
for participant's relatives	Lir. 10.000,-

Lecturers do not have to pay this registration fee.

At the beginning of the meeting all participants will receive the abstracts of reports and communications and the published Proceedings will be available afterwards.

Those persons wishing to deliver a paper or a brief communication should notify the secretary's office before the end of February 1974 at the latest. Inscription forms and other documents concerning the congress have been sent to all members of the World Association for Buiatrics. For non-members these forms will be available from:

The Secretary of the Organization Commitee:
Prof. G. Vacirca
Via Celoria 10
20133 Milano / Italy

or from:

The Secretary's Office of the
World Association for Buiatrics:
Prof. Dr. Dr. h. c. G. Rosenberger
Bischofsholer Damm 15
3 Hannover / Western Germany

INLIGTING

NASIONALE TOEKENNING AAN ONDERSTEPOORT

Die Nasionale Toekenning van die Geassosieerde Wetenskaplike en Tegniese Verenigings van Suid-Afrika vir hoogstaande wetenskaplike en tegnologiese prestasie is vanjaar toegeken aan die Entstofnavorsing en -produksiespan van die Navorsingsinstituut vir Veeartsenykunde op Onderstepoort.

Die toekenning, 'n goue medalje, is op 21 November 1973 tydens die Algemene Jaarvergadering van die Geassosieerde Verenigings oorhandig.

Vanjaar se toekenning word gedoen uit erkenning vir die hoogstaande werk wat op die gebied van entstofbereiding en verwante navorsing by die Navorsingsinstituut vir Veeartsenykunde gedoen word. Dié werk is nie alleen van groot wetenskaplike betekenis nie, maar ook van groot praktiese en ekonomiese belang as in aanmerking geneem word tot hoe 'n mate die veestapel in die Republiek, asook dié in aangrensende en ander Afrikalande, daarby baat. Baie van die veesiektes wat vroeër groot skades veroorsaak het, is tans grootliks onder beheer, danksy die entstowwe wat deur Onderstepoort verskaf word.

'n Voorbeeld van die goeie resultaat van doelgerigte navorsing oor 'n siekte was die onlangse ontwikkeling van die entstof teen ensootiese aborsie by skape. In dié geval is die entstof binne 13 maande vrygestel nadat die siekte in die Republiek uitgebreek het.

INFORMATION

NATIONAL AWARD TO ONDERSTEPOORT

The National Award by the Associated Scientific and Technical Societies of Southern Africa for outstanding scientific and technological achievement has been accorded this year to the Vaccine Research and Production Team of the Veterinary Research Institute, Onderstepoort.

The award, a gold medal, was presented on 21 November, 1973, at the Annual General Meeting of the Associated Societies.

This year's award has been made in recognition of the outstanding work in the field of vaccine production and related research done at the Veterinary Research Institute. This work is not only of great scientific significance but also of practical and economic importance if the enormous benefit to the livestock industry of the Republic and of adjoining territories is taken into account. The devastating effect of many diseases of livestock has been brought under control thanks to the vaccines supplied by Onderstepoort.

An example of the salutory results of purposeful research into a disease was the recent development of a vaccine against enzootic abortion of sheep. In this case a vaccine was made available 13 months after the disease had been recognized in the Republic.

New methods are continually being applied to the techniques of vaccine production to

Ook op die tegniek van entstofbereiding word by die Instituut steeds nuwe metodes toegepas om die doeltreffendheid van entstowwe te verhoog. So is vroeër vanjaar 'n verbeterde olie-hulpmiddel-entstof teen bloednier vrygestel. Waar in die geval van die ou entstof herhaalde inspuitings noodsaaklik was om volgehoue immuniteit te handhaaf, gee 'n enkele inspuiting van die nuwe entstof beskerming vir minstens 12 maande. In die geval van anaplasmose (galsiekte) is 'n entstof verkry met 'n langer houvermoë as die oue.

Te Onderstepoort is ook vir die eerste keer in die wêreld daarin geslaag om spesifieke antitoksiene te ontwikkel teen die C_1, C_2 en D-faktore van *Clostridium botulinum* — die oorsaaklike organisme van lamsiekte.

In die vorige verslagjaar is 128 miljoen dosisse van 32 verskillende entstowwe by Onderstepoort geproduseer waarvan ruim 6½ miljoen dosisse na ander Afrikalande uitgevoer is.

enhance the efficacy of vaccines. Earlier this year, an improved oil adjuvant vaccine against pulpy kidney disease was released. Whereas with the previous vaccine repeated inoculations were required to maintain immunity, a single injection of the new vaccine affords protection for at least 12 months. In the case of anaplasmosis a vaccine has been produced with longer keeping qualities.

At Onderstepoort, too, for the first time in the world specific antitoxins against factors C_1, C_2 and D of *Clostridium botulinum* — the causal organism of botulism — were developed.

During the previous year covered by the annual report, 128 million doses of 32 different vaccines have been produced at Onderstepoort, of which 6½ million doses have been exported to other African countries.

INFORMATION INLIGTING

LIVESTOCK "TRICKED" TO EAT MORE

Modern high-energy feed rations tend to produce a "full" signal from the brain, and animals stop eating before their stomachs are full. This is particularly true in feedlots and dairy operations where the trend is towards large amounts of grain concentrates and small amounts of roughage for the purpose of increasing milk and meat yields.

Experiments to trick livestock and dairy cattle into eating more feed than they normally consume, indicate a new approach to more economical meat and milk production.

The researchers, A. D. Peterson, Dr B. R. Baumgardt and Dr C. A. Baile, Department of Animal Science at Pennsylvania State University, have been able to increase short-term feed intake of calves and sheep tenfold, by injecting a small amount of the tranquilizer pentobarbital, into a specific area of the brain, studies having shown that certain areas of the brain control the feeding behaviour of animals.

Dr P. J. Wangsness, a member of the animal nutrition faculty is working with the research team to determine exactly how the control mechanism of feed intake operates. Thus far, the work has shown that the brain in cattle and sheep has "feeding centres" — which signal the animal to start and stop eating.

A unique, electronically controlled feeding unit is used by the team for these experiments. Employing a rotating turntable, the unit allows the animal to eat and drink whenever it wishes to do so. The device measures the frequency and duration of eating and the size of the meals. It also helps to identify changes in level of digestive end-products in blood or rumen fluid which may act to control feed intake.

Sheep placed in the feeder units are surgically equipped with plastic 'sampling' tubes. These tubes enable researchers to remain outside the feeder unit while withdrawing blood or rumen fluid from the undisturbed animal.

The sheep experiments reveal rapid changes in level of blood and rumen fluid metabolites such as volatile fatty acids, before. during, or after feeding. Blood levels of hormones, such as insulin, also fluctuate and may be a part of the signal carried to the feeding centres of the brain.

Equipped with adequate information, farmers could increase feed intake above that now possible for milking cows and meatproducing animals. On the other hand, farmers could more easily limit the feed intake for mature, non-milking livestock.

Agricultural Report No. 67, Agricultural Counsellor (Scientific) Embassy of South Africa, 3051 Massachusetts Avenue, N.W., Washington D.C. 20008, USA. Published by Agricultural Technical Services, Pretoria.

In Memoriam

Max Theiler 1899—1972

On the first anniversary of the passing away of Max Theiler on August 11th, 1972, it is fitting to pause for a moment to reflect on the life and work of this eminent scientist. It is not the intention to review the many and varied scientific publications which recorded the results of his investigations over the years. In the memory of his contemporaries and of future generations his contribution to the study of yellow fever virus and in particular to that of arthropod-borne viruses in general will remain indelibly engraved.

Born on 30th January, 1899, at Daspoort in the District of Pretoria, Transvaal, Max Theiler was the youngest child of Arnold Theiler and Emma Jegge. During their early childhood, both at Daspoort and later at Onderstepoort, the Theiler children were encouraged to spend their time out of doors as field naturalists. They were taught, *inter alia* by Professor Jansen and Austin Roberts, to preserve and study the various specimens which they collected and by example of their astute father they were encouraged to develop their powers of observation.

As a scholar Max Theiler was considered bright but suffered from the dubious advantage of always being the youngest member of his class. His junior schooldays were spent at Loreto Convent, later, in senior school, he was a pupil at the Pretoria Boy's High School. He commenced his university career by attending first Rhodes University, Grahamstown and later the South African College, Cape Town, where he completed his two year premedical course.

During the 1918 epidemic of influenza, all registered medical students, if not ill themselves, where called upon to assist the few remaining healthy doctors to minister the sick in the poorer areas of Cape Town. In those days the full course in medicine was not available in this country and so it was that after the termination of World War I he entered St. Thomas London, where he qualified as a licensed practitioner.

The association between poverty and disease was again to make an impression on him for many of the patients of St. Thomas Hospital were residents of the poorer areas of London. Whether it was this association of poverty and disease or perhaps some unanswered problem in his enquiring mind which made him decide to change his studies, is not known; however, the decision to take a four months course in tropical medicine and hygiene at the London School of Tropical Medicine no doubt opened the door to his future career. It was fortunate that Dr. O. Teague of the Havard Medical School at Boston, U.S.A., also attended the course. He offered Max Theiler an appointment as an assistant. In 1922 Max set sail for the United States and joined the staff of the bacteriologist, Dr. Andrew Sellards, to form an association that was to last until 1930. It was not long before Sellards and Theiler found themselves involved in the study of yellow fever.

There is little doubt that the work and interests of Max Theiler were influenced by his experience of tropical disease in Africa. During the period from 1926 to 1927, under the leadership of

R. Strong, Harvard sponsored an African expedition to the Republic of Liberia, the Belgian Congo, Uganda and Kenya. Although yellow fever was not encountered by the expedition, Theiler gained valuable experience in his particular assignment, which was the study of protozoal parasites of small mammals, as well as human trypanosomiasis. He returned via South Africa, where, unfortunately, there were no prospects for an appointment. Back in Boston Theiler resumed work on the nature of yellow fever on the few strains available.

In 1928 Max Theiler married Lillian Graham; their son, Arnold, was born in 1929. Tragedy unfortunately struck the family through the untimely death of young Arnold in a motor accident in 1937. A daughter, Elizabeth, was born in 1939.

In 1928 Sellards returned from a visit to West Africa with the French strain of yellow fever from Dakar in a sample of infected, frozen monkey liver. Believing that yellow fever was of a bacterial aetiology, he carried on with his investigations and left Theiler to follow up his own theory that the disease was caused by a virus. Not only did Theiler succeed, but he was able to adapt the virus to brain tissue of the Swiss strain of white mice by means of serial passage. This finding led to the development of the mouse-protection test for identification of yellow fever antibodies in human serum.

In 1930 Theiler was offered a post under William Sawyer at the Rockefeller Foundation where he continued his work on yellow fever and other viruses. By this time the Foundation was well established, with teams of scientists working in the field in various parts of the world; the prospects of new spheres of activity for Theiler were good.

As result of his efforts the now famous 17D strain was developed and in March 1937 Theiler and Smith reported that they had produced an attenuated virus which was an efficient immunizing agent. During the years 1937 to 1940 the vaccine was tested under field conditions in Brazil with great success.

In July, 1936, Max Theiler attended the Second International Biological Congress in London, where he reported on his studies on yellow fever. He was looking forward to this occasion and to hear his father's comments on his achievements, for Sir Arnold was to have been present; unfortunately this was not to be, for Sir Arnold passed away while in London, before he had presented his paper.

A few years later an opportunity arose for Theiler to study the epidemiology of the disease in the field, during a period spent in Columbia, at the laboratory in Bogota and later in the foothills of the Andes.

During the war years Theiler published his studies on many aspects of human poliomyelitis carried out on mice, including the discovery of mouse encephalomyelitis virus, and on experimental studies on the treatment of malaria, including avian malaria.

Public recognition of the work and success which had been obtained with the control of yellow fever came in 1951 with the award of the Nobel Prize for Physiology and Medicine. The citation stated that the award took into account the attenuation of the virus and the subsequent development of a vaccine. The committee making the award emphasized that the award was based not on originality but an recognition of a service to mankind. To this quiet-spoken, unassuming man perhaps one of the most enjoyable days of his life was on August, 1955, when he received the honorary citizenship of the Theiler ancestral town of Hasle in Switzerwnd.

With the realization of their responsibilities towards international health, member states of the United Nations established the World Health Organization in 1958, which meant that privately sponsored philantropy in international problems fell away. Gradually the Rockefeller International Health Board was phased out and eventually ceased to operate in 1958. The Foundation, however, continued its investigations, placing emphasis on the study of viruses in general and the arthropod-borne viruses in particular. Sawyer had retired in 1944 and in the course of time the directorship fell to Theiler. In 1950 he visited South and East Africa to see what progress had been made. The result of this exploratory visit was that Theiler presented to the Foundation a project which aimed at a world-wide study of the arthropod-borne virus diseases of man and his domestic animals. This project was accepted, but because it was so vast, the Foundation could not be expected to undertake all the investigatory work itself; it was proposed to enlist the co-operation of interested countries.

In the years that followed Theiler was to make a number of visits to Africa, India and South America in order to establish laboratories and review the progress made by the teams of scientists working in the tropics. A great deal of time was taken up by administrative matters, yet Theiler found much satisfaction in his work. He is quoted as saying "our virus programme is still flourishing. It is the most stimulating and worthwhile undertaking with which I have ever been associated, never a dull moment and always something new to keep us stimulated."

"The arthropod-borne viruses of vertebrates, being an account of the Rockefeller Foundation work between 1952-1970," with Theiler as author and W.G. Downs as co-author, finally went to press in February, 1971.

In pursuance of its phasing out policy, the Rockefeller Foundation was looking for an established university laboratory to continue its work. Yale University was in need of a building for its School of Epidemiology and Public Health, a situation which led to the transfer of the responsibility for the administration of this organization to the University. This move also suited Theiler, who became Professor of Epidemiology until 1967, when upon reaching the mandatory retiring age he was appointed Professor Emeritus.

In 1969 Theiler was still actively engaged, but by the end of 1970 he was obliged to content himself with shortened visits to the laboratory in order to keep his virus strains in order. Towards the end of 1971 he suffered a heart attack which weakened him considerably and brought to an end his enthusiastic and vigorous activities in the study of the viruses of insects and man.

Besides the Nobel Prize and Honorary Citizenship of the town of Hasle, Max Theiler had received the Chalmers Medal of the Royal Society of Tropical Medicine and Hygiene in 1939, the Harvard University Flattery Medal in 1945 and the Lasker Award of the Lasker Foundation in 1949.

Theiler's work must be evaluated firstly in the light of his discoveries concerning yellow fever at a time when techniques, which are now practised as a routine in virology, were in their infancy, secondly for his pioneer efforts to understand the arthropod-borne viruses.

Jl S. Afr. vet. Ass. 44 (4) : 463—464 1973

In Memoriam

Gilles van de Wall de Kock 1889—1973

By the death of Gilles van de Wall de Kock on 28 August, 1973, the veterinary profession in South Africa lost one of its most distinguished research workers. He was born in Pretoria on 1st December 1889, attended the Eendracht School and subsequently studied for one year at the Transvaal University College (now the University of Pretoria). He was one of the second two students sent to England by the Transvaal Government in 1909 to study veterinary science. In London he was a contemporary of the late C. Louis Leipoldt. He qualified as M.R.C.V.S. in 1913 and in February, 1914, was appointed to the staff of the Veterinary Laboratory at Onderstepoort under Arnold Theiler. His work included a spell at the Lamsiekte Research Station, "Armoedsvlakte".

In 1919 he left to study medicine in London but was unable to settle down and returned to South Africa in 1920 to take a post as lecturer in the newly created Faculty of Agriculture at Stellenbosch. On the assumption that the proposed Veterinary Faculty was to be established there, he was offered the Chair of Anatomy. With the creation of the Veterinary Faculty at Onderstepoort as part of the Transvaal University College, he was appointed Professor of Anatomy. In 1923 he spent a year at Berne and obtained the Dr. med. vet. degree.

His main interest lay in pathology and his studies were aimed towards that discipline. Upon his return he assumed the Chair of Pathology in 1924 and was appointed Professor of Comparative Pathology in 1938, which position he held until his retirement. His chief love was pathology and he built up the department from a small beginning to what it is today with its splendid museum. His work on pathology covered a wide range and he was responsible for a large number of important publications. He was particularly interested in haematology and the R.E. system. Co-workers and students were inspired by his dynamic enthusiasm.

Apart from his teaching and his own research work, he played a distiguished rôle in the general research work and administration of Onderstepoort and of the field work, first under Sir Arnold Theiler and later under Dr. P.J. du Toit, becoming Subdirector in 1927 on Sir Arnold's retirement and Deputy Director when that post was created in 1937. He succeeded P.J. du Toit as Director of Veterinary Services and Dean of the Faculty of Veterinary Science in 1948.

In the early 'thirties he spent a year of study in Europe, working most of the time under the celebrated German pathologist, Aschoff. Later he visited the United States of America on a Carnegie Grant - his main interest here was Alexis Carrel's tissue and organ culture work - and again in 1948 on a short visit.

He obtained the D.Sc. degree at the University of the Witwatersrand in August 1928, and the Medal and Grant of the South African Association for the Advancement of Science in 1949, in which year he was also President. He was a member of the South African Biological Society and was awarded the Senior Captain Scott Medal in 1933. He was also a Fellow of the Royal Society of South Africa and an Associate Member of the

Royal College of Veterinary Surgeons.

Dr De Kock retired in November 1949 and went to live in Cape Town, where he continued to work as an Honorary Research Associate at the Liesbeek Cancer Clinic, until ill health forced him to give it up.

He married Miss Myra Wahl (born on 26th March 1889) in Pretoria in 1914; they had two children, a daughter, Mrs. Duncan Brinkman, who survives them, and a son Gilles Alexius, who as a young man was killed in a tragic motor accident in 1970 in Cape Town, where he was stationed as Lieutenant in the Air Force. This had been a terrible shock to his parents. Mrs De Kock pre-deceased her husband on May 1st, 1966. The ashes of both parents are interred in the grave of their son in the old military cemetery at Voortrekkerhoogte.

The writer was associated with Gilles for 65 years, first as a student in London and afterwards as a colleague. We enjoyed a friendship which endured to the end. He was a man of high principles and great personal charm, as well as an indefatigable worker; I appreciate very much having been asked to contribute this memoir.

E.M.R.

PUBLICATION — PUBLIKASIE

DOCUMENTATION OF THE FIRST EUROPEAN VETERINARY CONGRESS AND TENTH GERMAN 'VETERINARY DAY' AND TENTH GERMAN 'VETERINARY DAY'

HELD AT

WIESBADEN 10—15 SEPTEMBER, 1972

The free issue of the Proceedings of the above meeting to those who have attended the Congress has been completed. Congress-goers who have not received their proceedings through faulty addresses should send their correct address to the sponsors.

Deutsche Tierärzteschaft e.V.
62 Wiesbaden,
Steubenstr. 34.

The present price is DM 35 per copy. Later editions, printed after exhaustion of present stock, will be more expensive.

INFORMATION — INLIGTING

THE POTENTIAL FOR INCREASED BEEF PRODUCTION IN THE PROVINCE OF BUENOS AIRES

At present the average production of meat per hectare per year for the province of Buenos Aires is roughly 70 kg. This value is extremely low for lands that are considered among the most fertile in the world and it suggests a tremendous inefficiency of meat production as it is presently conducted in the best lands of Argentina. Experiments currently underway on permanent artficial pastures at two of INTA's research stations, namely in Pergamino and Balcarce, dramatically show what potential exists.

(Condensed from La Prensa, Clarin, Dinamica Rural, October 1972. **Agricultural Report** No. 3, Agricultural Counsellor, South African Embassy, Marcelo T. de Alvear 590, Buenos Aires, Argentina. Published by the Department of Agricultural Technical Services, Pretoria).

In Memoriam

J.L. Dickson 1900—1973

John Liston Dickson was born in Kimberley on the 24th September, 1900. He was educated at the King Edward High School, Johannesburg and was one of the early groups of veterinary students at Onderstepoort, qualifying in 1926.

He immediately joined the Government Service, was stationed as Government Veterinary Officer at Dundee, Nongoma, Louis Trichardt and Piet Retief and also had a spell on the check staff.

In 1940 he enlisted in the second World War and for a time saw service in Madagascar.

After the war he was appointed Government Veterinary Officer at Bedford, then Bloemfontein. Here he was promoted to Sub-Director of Veterinary Services of the Free State, later he held that post for the Western Cape Province.

After he had left the Government Service at the end of 1961, he joined the Department of Nature Conservation of the Cape Province as officer in charge of the Predator Control Research Station, Vrolijkheid, Robertson, from where he retired in 1966 to settle at Robertson.

John was interested in Caledonian Society affairs and was at one time chief of the Bloemfontein Society and chieftain for the Free State. He was also chairman of the Robertson Literary Society.

He passed away suddenly on August the 6th 1973 after a prolonged period of ill health. John was a conscientious worker, a very capable administrator, a true observer of the professional code, a fine gentleman and true friend.

He leaves a widow, Joan (nee Turner), whom he married in 1933, two sons, four daughters and eight grand-children, to whom we extend our sincerest sympathy.

In Memoriam

Philippus Johannes Neethling Roosegaarde Bisschop 26.5.1932—14.7.1973

We honour the memory of our friend and colleague after his tragic passing as a result of a motor accident which occurred during the execution of his professional duties.

Philip was born in Pretoria and received his secondary schooling at the Pretoria Boys High School. He followed in his father's footsteps by entering the Faculty of Veterinary Science of the University of Pretoria, graduating in 1954. After registering with the Royal College of Veterinary Surgeons and practising in Britain, he proceeded to Canada where he spent 18 months in general practice in Edmonton, Alberta. He was held in high regard by his colleagues and clients in Edmonton.

On his return to South Africa he worked in various centres before finally setting up his own practice in Northdene, Durban.

Philip was an outstanding exponent of the veterinary art and science. He loved his work and enjoyed practice to the full, becoming totally dedicated to his patients and their owners. The reaction of his clients and friends to the news of his passing bears eloquent testimony to this fact.

He was a credit to his profession — a gentle man and a gentleman. To his wife June, their son Shahn, his father and colleague brother we extend our heartfelt sympathy.

J. v. N. / L. W. v/d H.

JOURNAL NEWS
FACULTY JOURNAL

The following excerpts from 'Newsletter of the Faculty of Veterinary Science' which appeared on the Faculty Campus, as a 28-page roneo'd information brochure and as a fore-runner of a proposed Journal, is reproduced here in the hope that alumni will not only take heed, but will respond.

COMMENT

Plans are already under way to introduce a Faculty of Veterinary Science Journal. It will be a twice yearly publication, the first issue of which will appear in the first half of next year.

The necessity of such a publication is real enough without having to resort to meaningless circumlocution to justify its existence, a necessity that has probably been emphasized since the consolidation of the Faculty as an educational institution.

Broadly speaking, the initial objectives to the journal are twofold: firstly to integrate the academic and extramural activities of the Faculty at both a staff and student level, and secondly to act as a medium by which topical faculty developments, academic or otherwise, may be brought to the attention of the Profession's members.

Besides a few exceptions, where various individuals outside the Faculty may be invited to contribute articles, the material for the journal should ideally originate entirely from the staff and students in order to maintain the emphasis on it being essentially a Faculty publication.

It should be stressed at this stage that owing to these circumstances, the success of the venture depends largely on the response obtained from the Faculty and the willingness of both staff and students to contribute articles; and further that the type of publication that is envisaged will cover as wide a subject range as possible in order to encourage greater diversity as regards the nature of the articles submitted.

To be more specific, some of the more immediate objectives, of the first few issues at any rate, are as follows:

-the extraction of ideas and opinions from staff members as regards the Profession as a whole. Merely by way of example, a subject under question at the moment seems to be the

TYDSKRIFNUUS
FAKULTEITSTYDSKRIF

Die volgende uittreksels uit „Nuusbrief van die Fakulteit Veeartsenykunde," wat onlangs as 'n afgerolde inligtingsbrosjure en voorloper van 'n beoogde Tydskrif op die kampus verskyn het, word hier weergegee met die hoop dat oudstudente nie slegs kennis sal neem nie, maar ook positief daarop sal reageer.

KOMMENTAAR

Die daarstelling van 'n Joernaal van die Fakulteit Veeartsnykunde is reeds ver in die beplanningstadium. Dit sal twee maal per jaar verskyn, die eerste uitgawe in die eerste helfte van aanstaande jaar.

Die noodsaaklikheid van so 'n publikasie is wesenlik genoeg sonder om nog toevlug te neem tot sinnelose omslagtigheid om sy bestaan te regverdig, 'n noodsaaklikheid wat seker beklemtoon is sedert die ontstaan van die Fakulteit as 'n onderwyseenheid.

Oor die algemeen is die aanvanklike doel van die tydskrif tweevoudig: Eerstens om die akademiese en buitemuurse aktiwiteite van studente en fakulteitspersoneel te integreer en om tweedens as medium te dien waardeur aktuele fakulteitsontwikkelinge, akademies of andersins, onder die aandag van lede van die Professie gebring kan word.

Nieteenstaande enkele uitsonderlike gevalle waar verskeie individue buite die fakulteit genader sal word om artikels by te dra, moet stof vir die joernaal liefs uit die geledere van die studente en personeel kom om sodoende die klem te behou dat dit in wese 'n fakulteitspublikasie sal wees.

Dit moet egter op hierdie stadium beklemtoon word dat, gesien in die lig van bogenoemde omstandighede, die sukses van die poging hoofsaaklik sal afhang van die ondersteuning van die Fakulteitskant en die bereidswilligheid van beide personeel en studente om artikels by te dra. Voorts sal die soort publikasie wat beoog word so wyd as moontlik 'n veld dek om sodoende 'n groter verskeidenheid van artikels te stimuleer.

future rôle of the Veterinarian in a fast increasing swing towards the intensification of stock farming with the concomitant awareness of more sophisticated production methods. Other subjects include the rôle of the practising veterinarian in dealing with the increased specialization within the Profession, the opportunities and direction of Veterinary research, etc.

-the publishing of interesting and worthwhile student class cases that would normally be relegated to oblivion and, as a result, be of no use to anyone except those few people that were directly involved in the case.

-the encouragement of constructive criticism as regards the tuition within the Faculty — something that no educational institution, however efficient, should hold itself aloof to.

-the publishing of current research developments that would be of use to the practising veterinarian.

-the creation of the opportunity to submit articles of a humorous, or perhaps more serious vein; there are surely some literary giants lurking undiscovered amongst us!

The fact that this is a completely new undertaking that still has to find its feet, allows great scope for suggestions and ideas that might be put to use to improve its appearance and the value of its contents. Any opinions here will be welcome.

Furthermore it remains to be said that any articles submitted should be typewritten, and that any photographs should be glossy prints where possible. The editorial committee reserves the right to edit and adapt any material accepted for publication and any material not published will be returned only on request.

Articles may be submitted to any member of the editorial committeé, which at the moment consists of the following: P. du Preez, F. Flanagan, J. van Rooyen, A. de Vos (Miss)

MESSAGE FROM THE DEAN : PROF. C.F.B. HOFMEYR

This first publication of the students from the faculty of Veterinary Science gives evidence of enthusiasm and perseverance, as the idea was theirs spontaneously, and has been carried further by their initiation despite problems encountered.

As demonstration, therefore, of desirable qualities in those who are due to be colleagues soon, the appearance of the journal is to be welcomed.

There is however, much more to it. The aim is to promote communication with the faculty, strengthening of the ties between the faculty and

Om meer presies te wees, is sommige van die onmiddellike doelstellings, in elk geval vir die eerste paar uitgawes, soos volg:

-die verkryging van gedagtes en menings van lede van die personeel in verband met die Professie as 'n geheel. Byvoorbeeld 'n bevraagtekende onderwerp op die oomblik blyk die rol van die veearts in die vinnig toenemende swaai na intensifisering van veeboerdery met die gepaardgaande bewustheid van meer gesofistikeerde metodes van produksie te wees. Ander onderwerpe sluit die rol van die praktiserende veearts in die toenemende spesialisasie binne die Professie in, ook die geleenthede en rigtings in veterinêre navorsing, ens.

-die publiseer deur studente van interessante en waardevolle kliniese gevalle wat normaalweg nie onder die aandag van andere sou gekom het nie en gevolglik vir niemand van waarde sal wees behalwe vir die paar wat direk daarby betrokke was nie.

-die aanmoediging van opbouende kritiek aangaande die onderrig in die Fakulteit, iets wat geen onderwysinrigting, al is dit hoe doeltreffend, kan verontagsaam nie.

-die publiseer van huidige ontwikkelings op die gebied van navorsing wat vir die praktiserende veearts van nut behoort te wees.

-die daarstelling van die geleentheid om humoristiese of selfs meer ernstige artikels te publiseer. Daar is sekerlik 'n paar groot letterkundiges wat onontdek tussen ons skuil!

Die feit dat hierdie 'n algehele nuwe onderneming is wat nog sy voete moet vind, bied geleentheid vir 'n groot reeks voorstelle en gedagtes wat ingespan kan word om die voorkoms en inhoudswaarde van die joernaal te verbeter. Menings word verwelkom.

Voorts moet daar nog genoem word dat alle artikels getik moet word en dat enige foto's wat ingedien word, waar moontlik 'n glansoppervlakte moet hê. Die redaksiekommissie behou hom die reg voor om enige materiaal wat aangeneem word vir publikasie te redigeer en te wysig. Ongepubliseerde materiaal sal slegs op versoek teruggestuur word.

Artikels kan by enige lid van die redaksiekommissie ingedien word. Die volgende persone dien daarop : P. du Preez, F. Flanagan, J. van Rooyen, A. de Vos (Mej).

its alumni and last but not least between members of the veterinary profession as a whole, as well as other related and friendly organizations.

The faculty with its lecturers and students can never stand apart from the profession it serves. This link, forged by the students, will therefore be a valuable counter against estrangement. As student numbers are to be doubled in the foreseeable future, initial understanding becomes doubly imperative.

It is hoped that colleagues, also those outside the faculty, will welcome the appearance of the journal and will contribute news items and anecdotes from their student days.

BOODSKAP VAN DIE DEKAAN : PROF. C. F. B. HOFMEYR

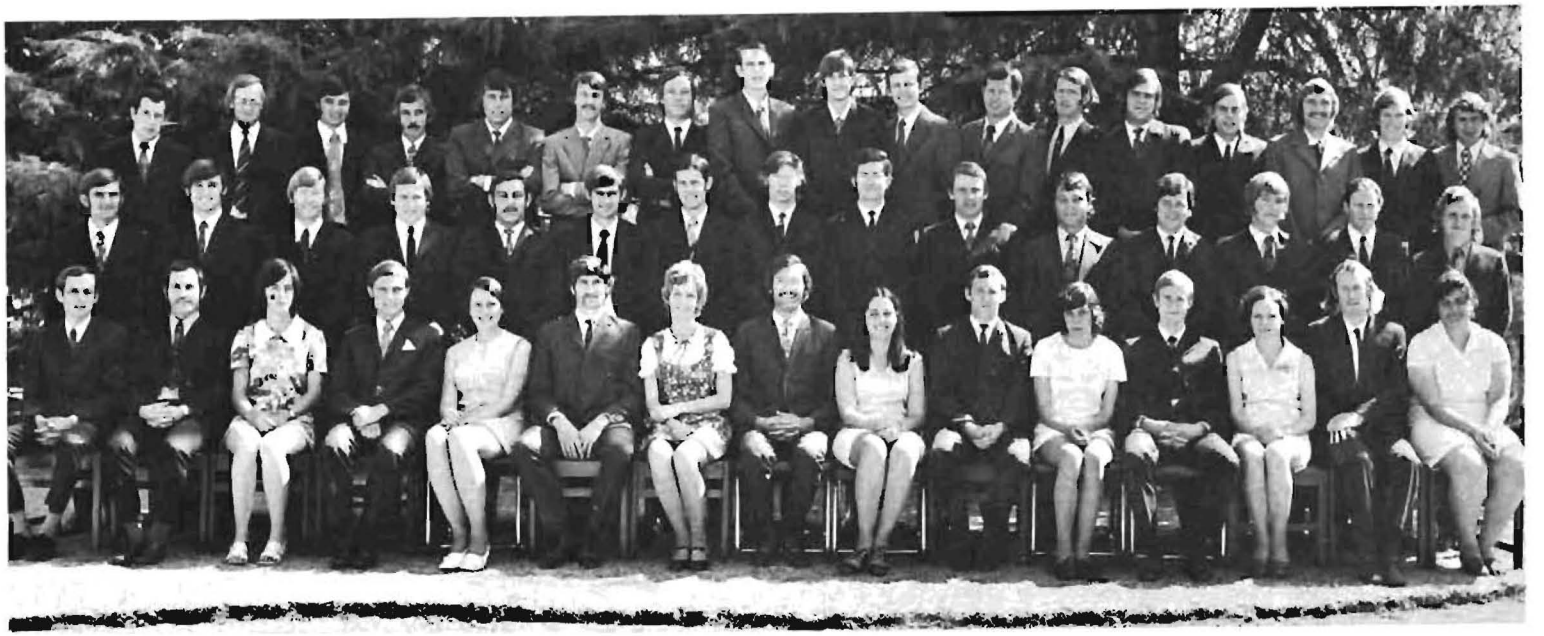
Geesdrif en deursettingsvermoë is sekerlik twee van die belangrikste bestanddele van sukses. Hierdie eersteling publikasie van die studente van die Fakulteit Veeartsenykunde gee blyke van beide eienskappe, veral geneem teen die agtergrond dat dit hulle eie spontane idee is en deur hulle inisiatief verder gevoer is tenspyte van probleme. As demonstrasie, dus, van gesogte eienskappe by diegene wat aanstonds kollegas sal wees, is die verskyning van die joernaal te verwelkom. Dit gaan egter om veel meer. Daar word gemik na bevordering van kommunikasie tussen die fakulteit, versterking van bande tussen hierdie fakulteit en sy alumni, en les bes, die verterinêre professie in sy geheel, sowel as ander verwante en bevriende instansies.

Die Fakulteit met sy dosente en sy studente kan nooit los staan van die professie wat hy dien nie. Hierdie skakel, deur studente daargestel, sal dus waardevol wees om neigings tot vervreemding teen te werk. Omdat studentegetalle in die afsienbare toekoms gaan vedubbel word onderlinge verstandhouding en begrip dubbel noodsaaklik.

Daar word gehoop dat kollegas ook buite die fakulteit die verskyning van die joernaal sal verwelkom en bydraes met nuusbrokkies en vertellings uit hulle studentedae van tyd tot tyd sal instuur.

FINAL YEAR STUDENTS 1973 FINALEJAARSTUDENTE

FACULTY OF VETERINARY SCIENCE FAKULTEIT VEEARTSENYKUNDE



First Row / Eerste Ry: J.A. van Zyl, M. Greenberg, Mej./Miss Y.D. Smith, R.C. Bester, Mej/Miss J.E. Schoeman, P.A. Vienings, Mej./Miss J.F.C. Herlê, R.F. Linde, Mej./Miss C.M. Pieterse, B.T. Spencer, Mej./Miss S.S. Bastianello, F.H. van der Vyver, Mej./Miss H.M. Coetsee, M.C. Williams, Mej./Miss A.L. Lange.

Second Row / Tweede Ry: L. Prozesky, G.E. Swan, R.W.B. Paterson, M. van Vuuren, J.A.W. Coetzer, H.J. Geldenhuys, E.R. du Preez, K. Passmoor, E.L. Lee, P.M. Gilfillan, A.P. Forsyth, C.A.P. Carrington, R.J. Antrobus, W.B. van der Meulen, D.R. Winkworth.

Third Row / Derde Ry D.F. Steyn, A Pretorius, J. van Deemter, J.L. Fourie, N.C.G. Henning. S.W. Nel, J. van Heerden, S.G.H. Meyer, P:C: Hope, R.M. Löfstedt. G.F. Briers, T.T. Collins, J.M. d'Offay, J.S. Vorster, R.B. Bousfield, B.M.T. Spencer, T.N. Duckham.

GRADUATES 1973 GRADUANDI

Antrobus, R. J.
Bartlett, J. A.
Bastianello, S. S. (mej.)
Bester, R. C.
Bousfield, R. B.
Briers, G. F.
Coetsee, H. M. (mej.)
Coetzer, J. A. W.
Collins, T. T.
Cowden, R. C.
D'Offay, J. M.
Du Preez, E. R.
Forsyth, A. P.
Fourie, J. L.
Geldenhuys, H. J.
Gilfillan, P. M.
Gordon, A. P.
Greenberg, M.
Henning, N. G. C.
Halliday, I. T.
Herle, J. F. C. (mej.)
Hope, P. C.
Lange, A. L. (mej.)
Lee, E. L.
Linde, R. F.
Löfstedt, R. M.
Meyer, S. G. H.
Passmoor, K.
Paterson, R. W. B.
Pieterse, C. M. (mej.)
Pretorius, A.
Prozesky, L.
Schoeman, J. E. (mej.)
Smith, A. W. H.
Smith, Y. D. (mej.)
Smuts, A. R. B.
Spencer, B. M. T.
Steyn, D. F.
Swan, G. E.
Van Aardt, M. P.
Van der Meulen, W. B.
Van der Vyver, F. H.
Van Heerden, J.
Van Vuuren, M.
Van Zyl, J. A.
Vienings, P. A.
Winckworth, D. R.

PRIZE AND MEDAL AWARDS

PRYS- EN MEDALJETOEKENNINGS

Arnold Theiler Memorial Medal
Arnold Theiler-gedenkmedalje
Bester, R. C.

Clinical Medal and Bag
Kliniese Medalje en Tas
Bester, R. C.

Lion Bridge Ethicals - Prize
Lion Bridge Ethicals - Prys
Bester, R. C.
Coetzer, J. A. W.

I.C.I. South Africa (Pharmaceuticals) Ltd.

Prys vir Chirurgie en Geslagskunde
Prize for Surgery and Genesiology
Prozesky, L.

Medicine and Infectious Diseases
Geneeskunde en Infeksiesiektes
Van Zyl, J. A.

Maybaker Clinical Prize
Kliniese Prys

Lange, A. L. (mej.)

Agricura Prize
Agricuraprys
Coetzer, J. A. W.

Pfizer Prize
Pfizerprys
Greenberg, M.

Prize awarded by the Reproduction Group of the SAVA
Prys toegeken deur die Reproduksiegroep van die SAVV
Forsyth, A. P.

Lilly Laboratory Prizes
Lilly Laboratorium-pryse

Diseases of Swine
Varksiektes
Williams, M. C.

Poultry Diseases
Pluimveesiektes
Coetzer, J. A. W.

The Faculty of Veterinary Science expresses its sincere appreciation and thanks to the donors of the above-mentioned medals and prizes.

Die Fakulteit Veeartsenykunde betuig sy besondere dank en erkentlikheid jeens die skenkers van bovermelde medaljes en pryse.

JOURNAL OF THE SOUTH AFRICAN VETERINARY ASSOCIATION

VOLUME 44 JAARGANG

TYDSKRIF VAN DIE SUID-AFRIKAANSE VETERINÊRE VERENIGING

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SUBJECT INDEX/INHOUDSOPGAWE

Scientific Communications Wetenskaplike Mededelings

Bold page number indicates senior or sole author.
Vetgedrukte bladsynommer dui enigste of senior outeur aan.

TREFFERBLAD

ACHALASIE IN DIE HOND VEROORSAAK DEUR BLYWENDE REGTER AORTABOOG

Twee Duitse Herderhondjies uit 'n werpsel van ses was aangebied met geskiedenis van swak groei, vermaering en aanhoudende „braak" na maaltye (Fig. 1). By kliniese ondersoek was slukdermverwyding by die borskasingang duidelik tasbaar. 'n Röntgenopname tien minute na 'n bariummaal het 'n groot slukdermdivertikel kraniaal van die die hart aangedui (Fig. 2). Die opeenvolgende stadia van die lykskouing na genadedood is in figure 3—6 uitgebeeld. Die opnames is gemaak na inspuiting van waterstofperoksied in die lumen van die slukderm ten einde die mate van uitsetting ten volle te toon.

Skematiese uitbeeldings (Figg. A—C) toon die onderliggende patologie.

Die voorkoms van twee gevalle in een werpsel hondjies dui sterk op oorerwingsinvloed.

Bydrae en fotografie: Dr. A. J. van Niekerk, Posbus 525, Vereeniging, 1930.

FEATURE PAGE

ACHALASIA IN THE DOG CAUSED BY PERSISTENT RIGHT AORTIC ARCH

Two Alsatian pups from a litter of six were presented with a history of poor growth, emaciation and persistent 'vomiting' after meals (Fig. 1). Upon clinical examination, dilatation of the oesophagus at the thoracic entrance could be palpated distinctly. A roentgenograph taken ten minutes after a barium meal indicated a large oesophageal diverticulum cranial to the heart (Fig 2).

The successive stages of the autopsy after euthanasia are depicted in figures 3—6. These photographs were taken after injection of hydrogen peroxide into the lumen of the oesophagus to reveal the extent of the dilatation. Schematic representations (Figs. A—C) outline the underlying pathology.

The occurrence of two cases in a litter of six strongly suggests hereditary influence.

Contribution & photography: Dr. A. J. van Niekerk, P.O. Box 525, Vereeniging, 1930.

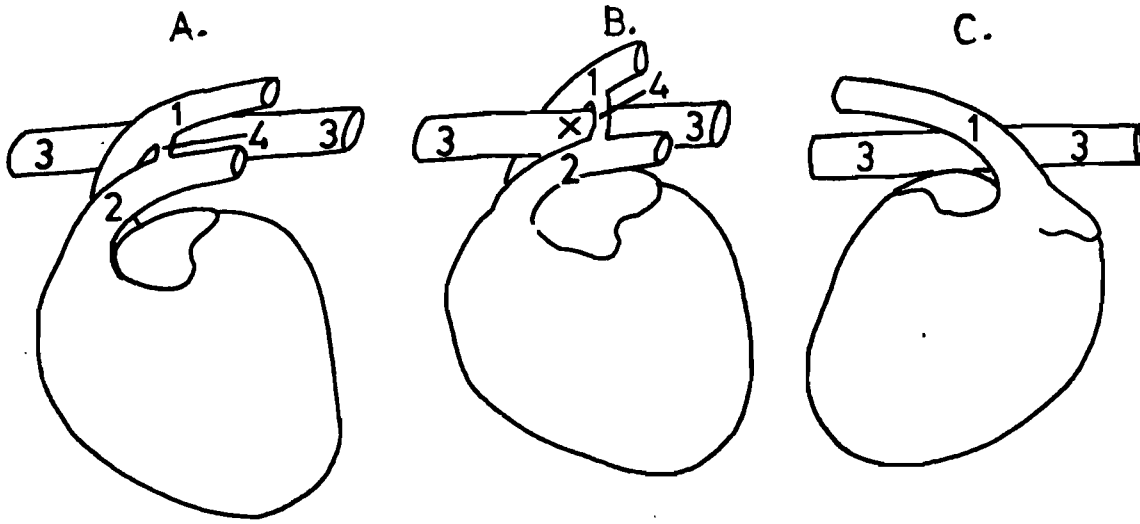

Fig. A. Linker aansig. Die normale topografie van hart, aorta (1), truncus pulmonalis (2), slukderm (3) en ligamentum arteriosum (4).

Fig. B. Linker aansig. Die topografie van hart, aorta (1), truncus pulmonalis (2), oesophagus (3) en ligamentum arteriosum (4) in gevalle van blywende regte aortaboog. X d_{11}i die streek van uitsetting, wat in enige rigting van minste weerstand mag plaasvind en 'n divertikel vorm. Die ligamentum arteriosum kan so diep bedolwe raak deur dorsale oorhang van so 'n divertikel dat dit moeilik vir chirugiese verdeling te vinde kan wees.

Fig. C. Soos voorgaande, regter aansig.

Fig. A. Left view. The normal topography of herat, (1), truncus pulmonalis (2), oesophagus (3) and ligame arteriosum (4).

Fig. B. Left view. The topography of heart, aorta truncus pulmonalis (2), oesophagus (3) and ligamentum art sum (4) in cases of persisitent right aortic arch. X indi the site of dilatation, which may extend in any directio least resistance, forming a diverticulum. The ligamentum riosum may become deeply buried by dorsal overhang of a diverticulum and very difficult to locate for surgical div

Fig. C. The same as before, right view.

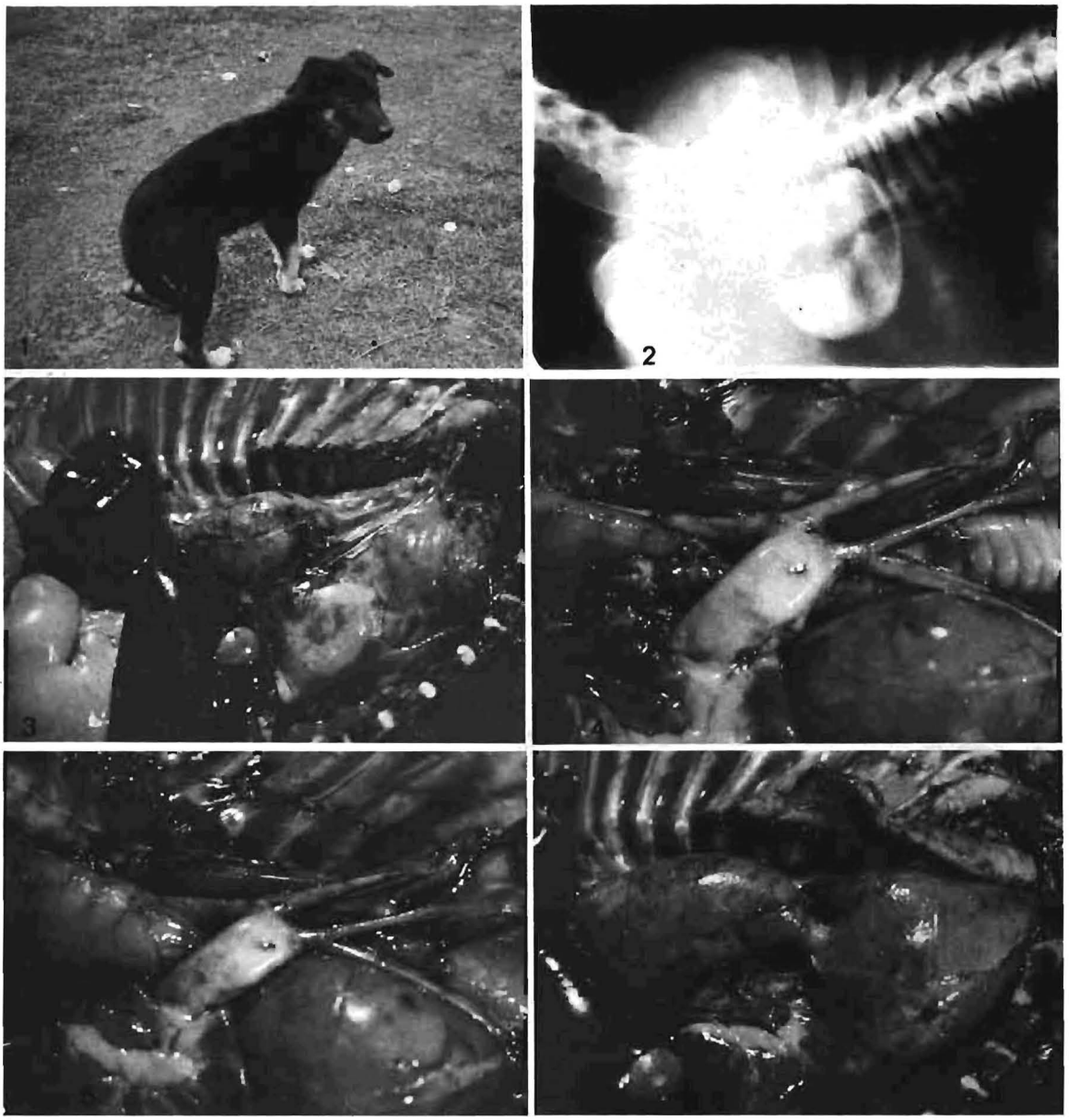

Fig. 1. Tipiese voorkoms van swak gedying met hare verkeerd en ingetrekte buik.

Fig. 2. Röntgenopname 10 minute na 'n bariummaal. Die divertikel wat as gevolg van uitsetting ontwikkel het, is duidelik omlyn.

Fig. 3. Borkskasorgane van regs gesien na opklap van die regter borswand en verwydering van die regter long.

Fig. 4. Naby-opname na uitdissekteer van aorta en takke Die aortatakke van dorsaal na ventraal sigbaar is: A subclavia dextra Tr. costocervicalis Tr. bicaroticus, wat uiteindelik in linker en regter gemeenskaplike nekslagare verdeel.

Fig. 5. Dieselfde na verwydering van die lugpyp.

Fig. 6. Dieselfde na verwydering van die aorta, om die slukdermvernouing te toon. Let op die uitgesette postkardiale slukdermsegment, 'n kunsproduk as gevolg van H_2O,—inspuiting.

Fig. 1. Typical appearance of a poor doer, with staring coat and tucked-up abdomen.

Fig 2. Roentgenograph 10 minutes after a barium meal. The diverticulum formed by the dilated oesophagus is clearly outlined.

Fig 3. Thoracic organs viewed from the right after deflecting the right thoracic wall upward and after removal of the lung.

Fig. 4. Close-up view after dissecting out the aorta and branches. The branches of the aorta visible from dorsal to ventral are: A. subclavia dextra. Tr. costocervicalis. Tr. bicaroticus, dividing eventually into left and right common carotid arteries.

Fig. 5. The same after removal of the trachea.

Fig. 6. The same after removal of aorta, to show the oesophageal constriction. Note the dilated postcardial segment of the oesophagus, an artefact as result of the H_2O, injection.