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CONTENTS / INHOUD

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JOURNAL OF THE SOUTH AFRICAN VETERINARY ASSOCIATION
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EDITORIAL

EXCORPORATION OF THE FACULTY OF VETERINARY SCIENCE

The excorporation of the Faculty of Veterinary Science from the Department of Agricultural Technical Services and its full integration into the University of Pretoria as from April, 1973, merits more than passing attention.

In historical perspective, this Faculty was the second to be established on the African Continent, namely in 1920. It was preceded by the Veterinary School in Cairo almost a century before. As far as can be ascertained, Arnold Theiler was the person who first formally mooted the idea of a faculty of veterinary science in this country; he did so in an official letter to the Secretary for Agriculture in 1912. For practical reasons this Faculty initially formed an integral part of what was then known as the Veterinary Laboratory of the Department of Agriculture at Onderstepoort, the Transvaal University College being responsible for the necessary academic status and student administration. Until 1950 the Director of the Laboratory and Veterinary Services was virtually automatically accepted as the Dean of the Faculty and for some time bore the official title of Director of Veterinary Research and Education.

The first teachers were all officials of the Department of Agriculture, and most of them by far were attached to the Laboratory. This entailed two advantages. Firstly, teaching was done by persons fully conversant with the country's veterinary problems and entirely involved in the research thereon. Secondly — and this was of vital importance to a young, developing country — the financial load could be kept to a minimum. From the existing body of officials teachers were appointed at a small additional remuneration of £200 per annum for a professor and £100 for a lecturer, on the understanding that all preparatory work had to be done out of official hours.

In terms of the Faculty's future developmental pattern, the first aspect was of fundamental importance. In retrospect both contained the potential for further evolution.

REDAKSIONEEL

UITLYWING VAN DIE FAKULTEIT VEEARTSENYKUNDE

Met die uitlywing van die Fakulteit Veeartsenykunde uit die Departement Landbouwetenskaplike Dienste en volwaardige integrasie in die Universiteit van Pretoria vanaf April 1973, is dit betaamlik om hierdie gebeure van nader te beskou.

Geskiedkundig gesien, was hierdie Fakulteit die tweede een om op die vasteland van Afrika te verskyn, en wel in 1920. Dit is slegs vooruitgegaan deur die Veeartsenyskool te Kairo, byna 'n eeu tevore. Sover vasgestel kon word, was Arnold Theiler die persoon wat die eerste gedagtes oor 'n veeartsenykundige fakulteit hier te lande formeel geopper het, te wete in 'n ampsbrief in 1912 aan die destydse Sekretaris van Landbou. Om praktiese redes was die Fakulteit van meet af 'n integrale deel van die destydse Veeartsenykundige Laboratorium van die Departement Landbou te Onderstepoort, terwyl die Transvaalse Universiteitskollege die nodige akademiese status verleen en studenteadministrasie behartig het. Tot 1950 was die Direkteur van die Laboratorium en van Veeartsenydienste feitlik vanselfsprekend die Dekaan van die Fakulteit en het hy vir geruime tyd die titel van Direkteur van Veeartsenykundige Navorsing en Onderwys gedra.

Die eerste dosente was almal beamptes van die Departement Landbou en verreweg die meeste was verbonde aan die Laboratorium. Dit het twee groot voordele ingehou. Ten eerste was die dosente persone wat vierkant in die land se veeartsenykundige probleme gestaan het en ten volle by die navorsing daaroor betrokke was. Ten tweede — en dit was 'n uiters belangrike oorweging in 'n jong, ontwikkelende land — kon die finansiële las tot 'n minimum beperk gebly het. Uit die bestaande amptenary is dosente aangestel teen 'n klein addisionele vergoeding van £200 per jaar vir 'n professor en £100 vir 'n lektor, op voorwaarde dat alle voorbereidende werksaamhede buite diensure sou geskied.

Eersgenoemde oorweging is van uiterste belang waar oor die toekoms en ontwikke-

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Justice could not be done to basic subjects which had little immediate application in the research programme of a young country riddled with relatively poorly known diseases. The same applied for the clinical subjects: in those days education was aimed primarily at the training of state veterinarians. The first fully fledged private practitioner was a graduate of 1934, who settled in Johannesburg in 1936 after further overseas' experience. Nevertheless, one cannot help but have the greatest respect for the admirable efforts of the first teachers. They were the people who lit the torch of idealism and set a tradition jealously guarded to this day. In fact, the toughest 'in-fights' in the Faculty are held to obtain more teaching time for a particular discipline, not to lighten the teaching load.

Clearly the practical and organisational dichotomy between operational research and teaching — not even to mention routine diagnostic and administrative loads — had to lead to a schism sooner or later. In addition, the financial problem arose of drawing teachers from a profession for which private practice had become increasingly remunerative. In spite of the increase of the annual teaching allowance in the late 'forties to £300 and £200 for professors and lecturers respectively, dissatisfaction over the niggardly re-imbursement grew. The year 1957 was a decisive one: thanks to strong action taken by the SAVA and after thorough official investigation by the Government, full-time teaching posts were created as from the beginning of 1958. The salaries were brought on par with those of the universities and a special professional allowance was added. Nevertheless, the Public Service Commission could not see its way clear to make the total salary pensionable. In the process, the number of teaching departments had to be reduced from sixteen to nine. All incumbents of future full-time posts had to resign and enter into open competition by application for such positions. Even so, exigency demanded that only seven of the nine departments could be headed by full-time professors. For a while this could be increased to eight, but had to be reduced again. A considerable number of lecturing posts had to remain on the basis of part-time work: organisational problems and trained man-power shortage prevented evolution to proceed to its logical climax. The agricultural faculties at the various South African universities simultaneously drew benefit from this re-organisation.

lingspatrone besin word. By terugblik het albei die kiem vir verdere evolusie ingehou. Basiese vakke, wat weinig onmiddellike toepassing gehad het in die navorsingsprogram van 'n jong land deurspek met betreklik onbekende siektes, kon nie tot hul volle reg kom nie. Dieselfde geld die kliniese vakke, want in daardie tyd was opleiding ten volle gerig op opleiding van staatsveeartse. Die eerste volwaardige private praktisyn was 'n 1934-graduant wat hom na buitelandse ervaring in 1936 in Johannesburg gevestig het. Daarenteen kan mens nie anders as om die pogings van die eerste dosente met grootste agting vir hul lofwaardige werk te bejeën nie. Hulle was die mense wat die fakkel van idealisme aangesteek het en beslag aan 'n tradisie gegee het; daardie fakkel brand steeds helderder en die tradisie word met na-ywer beskerm. Selfs vandag gaan die kwaaiste „binne-gevegte" in die Fakulteit om meer onderrigtyd vir 'n vakgebied te verkry, nie om die doseerlas te verlig nie.

Duidelik moes die organisatories-praktiese dichotomie tussen operasionale navorsing en onderwys — om van die roetine-ondersoek en administratiewe las nie eers te praat nie — vroeër of later tot 'n wegbreekpunt lei. Daarby het die finansiële probleem ontstaan om dosente te trek uit 'n beroep waarin private praktyk al hoe meer lonend geword het. Ten spyte van die verhoging van die doseertoelaag van professore en lektore na onderskeidelik £300 en £200 per jaar in die laat veertigerjare, het die karige loon steeds groter ontevredenheid geskep. Die jaar 1957 was beslissend: dank sy die sterk optrede van die SAVV en na deeglike ondersoek van staatskant is heeltydse doseerposte geskep vanaf aanvang 1958. Die salarisse is op peil van dié aan die univeriteite gebring en 'n spesiale professionele toelaag is bygevoeg. Desnieteenstaande kon die Staatsdienskommissie nie kans sien om die totale salaris pensioenbaar te maak nie. In die proses is die getal fakulteitsdepartemente van sestien na nege verminder. Alle voornemende bekleërs van heeltydse poste moes bedank en in ope wedywering aansoek om sodanige poste doen. Onder druk van nood kon slegs sewe van die nege departemente deur 'n heeltydse professor gelei word. Vir 'n kort tydperk kon dit na agt vermeerder word, daarna is dit weer verminder. 'n Aansienlike aantal lektorate moes nog deeltyds beman word, omrede organisatoriese probleme en tekort aan geskoolde mannekrag: die evolusie

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Another augury of complete dichotomy was the break-away from the tradition that the Director of Veterinary Services should also be Dean of the Faculty. This was the case from 1950 to 1963, and again from 1969 onwards.

To effect greater rationalisation in the staffing of the agricultural faculties, an investigation committee (Brink Committee) was appointed by the Government. Customarily, the Faculty of Veterinary Science was also involved. The control of a Faculty partly as an appendage of a State Department, partly as an appendage of a university, came under close scrutiny. After acceptance of the Committee's main findings and initial postponement of the date for one year, the first of April, 1973, was determined as D-day for the Faculty of Veterinary Science. Because of previous rationalisation, the intended decrease from nine to six departments was not accepted by the Senate and Council of the University of Pretoria (formerly, until 1930, the Transvaal University College).

Considerable time will have to elapse before all the implications of this organisational change become apparent. The following considerations are offered as food for thought in order to obtain maximum advantage from the favourable circumstances and to reduce the disadvantages to a minimum.

One may reasonably expect tertiary education and the more basic types of research to flourish better in a purely academic atmosphere with its comparatively smaller, but more pliable and specifically purpose-orientated organization, and more rapid executive mode of action. Contact between professional and administrative personnel — the eternal point of friction arising from the so human misunderstandings and misconceptions — is more direct and personal, the highest authority in the hierarchy more approachable and accessible. Undoubtedly, there will be a period of adjustments of personalities and methodologies. The members of Faculty will have to learn more thoroughly the *modi operandi* of the University and *vice versa*, both will have to gain better insight into each other's unique problems; fortunately they are not complete strangers to one another. There is every indication that a spirit of mutual good-will exists, with an exalting effect on general morale. The practical problems — and they are legio — are seen rather as a challenge. One cannot leave this aspect without a word of appreciation to those

gemaak van die aansienlike ongerymdheid tussen kosteberekenings van die Departement kon nie tot sy logiese klimaks volvoer word nie. Die landboufakulteite aan die Suid-Afrikaanse universiteite het insgelyks by dié proses gebaat.

'n Ander voorteken van volledige dichotomie was die verbreking van die tradisie dat die Direkteur van Veeartsenydiens vanselfsprekend Dekaan sou wees. Dit het van 1950 tot 1963 en daarna sinds 1969 plaasgevind.

In 'n poging om groter rasionalisasie in die landboufakulteite te bewerkstellig, is 'n ondersoekkomitee (die Brink-komitee) in die lewe geroep. Gebruiklikerwys is die Fakulteit Veeartsenykunde ook in die ondersoek betrek. Van die geleentheid is gebruik gemaak om die onvermydelike praktiese probleme verbonde aan die beheer van die Fakulteit, enersyds as 'n aanhangsel van 'n staatsdepartement, andersyds as 'n aanhangsel van 'n universiteit, onder die soeklig te bring. Na aanvaarding van die komitee se hoofbevinding ten gunste van uitlywing en na aanvanklike uitstel van die datum vir een jaar, is 1 April 1973 deur die Minister van Landbou as D-dag vir die Fakulteit Veeartsenykunde bepaal. Omrede vroeëre rasionalisasie is die beoogde vermindering van nege na ses departemente nie deur die Raad en Senaat van die Universiteit van Pretoria (voorheen, tot 1930, die Transvaalse Universiteitskollege) aanvaar nie.

Dit sal geruime tyd duur eer die volle implikasies van hierdie organisatoriese omskakeling duidelik word. Die volgende gedagtes word ge-opper om denke te prikkel, sodat maksimum voordeel uit die gunstige aspekte getrek en die nadele tot 'n minimum beperk kan word.

'n Mens kan redelik verwag dat tersiêre opleiding en die meer basiese navorsing beter in 'n suiwer akademiese atmosfeer sal kan gedy, met sy vergelykenderwys kleiner, maar soepeler en meer spesifiek doelgerigte organisasie en sneller uitvoerende werkwyse. Kontakte tussen professionele en administratiewe personeel — die ewige wrywingspunt weens die so menslike misverstande en wanbegrippe — is meer direk en persoonlik, die hoogste gesag in die hierargie meer bereikbaar en toeganklik. Ongetwyfeld sal daar 'n tydperk van persoonlike en metodieksaanpassing moet wees. Die fakulteitslede sal die Universiteit se *modi operandi* deegliker moet leer ken en omgekeerd, met beter insig in en begrip vir mekaar se eiesoortige probleme.

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Directors of Veterinary Services who have assisted the Faculty in the past to the utmost within the bounds of civil service regulations, even though they had not necessarily been concerned directly with Faculty teaching or administration. To the authorities and administration of the University of Pretoria thanks are given for the way in which they have been able to ward off a number of impending initial crises and for their readiness to help.

There will be many who, with all justification, will bemoan the fact that the present Institute for Veterinary Research could not have celebrated its independence as a state-subsidized, autonomous body together with the Faculty. Then the divorce after a marriage that had already celebrated its golden jubilee would have been less traumatic. Then a number of logistic problems could have been solved more efficiently and more economically. Be that as it may, a number of such problems stare the Faculty in the face; they must and shall be solved with the proper good-will.

The fundamental problem is one of finance. State budgeting within a Department is done according to category rather than in terms of smaller functional units. Within the total framework and within certain practical bounds this is simpler and more efficient. But by the same token nobody has any idea exactly what it costs annually to run the Faculty. It would have taken teams of costing accountants considerable time to determine this figure even by approximation. All at once now, it has been necessary to determine what amount of its budget the Department of Agricultural Technical Services will have to channel to the Department of National Education for subvention of the University, the latter Department as yet totally ignorant of the unique needs of the Faculty. Where the Government has had to cut back Departmental budgets rigorously in the face of public opinion, one dare hardly expect any munificence. Authoritative bodies have already pointed out the considerable discrepancy between the cost as calculated by the Department of Agricultural Technical Services and the University. The burning question is whether the powers that be fully realize the inescapably high costs* associated with the running of a faculty of veterinary science. There are some indications that they do, fortunately. Notice has been taken, with

Daar is alle aanduidings dat daar 'n wedersydse goeie gees heers, met opbeurende invloed op die algemene moreel. Die praktiese probleme — en daar is legio — word eerder as 'n uitdaging gesien. 'n Mens kan nie van hierdie punt afstap sonder om met waardering gewag te maak van dié Direkteure, wat die mate van soepelheid wat die Staatsdiens kon bied, sover moontlik binne die perke van regmatigheid benut het om die Fakulteit van hulp te wees, selfs al was hulle nie noodwendig direk by die onderwys of administrasie van die Fakulteit betrokke nie. Aan die owerhede en administrasie van die Universiteit van Pretoria kom waardering toe vir die wyse waarop hulle dreigende aanvangskrisisse besweer het en vir hulle gees van hulpvaardigheid.

Daar sal etlikes wees wat dit met alle reg betreur dat die huidige Navorsingsinstituut vir Veeartsenykunde nie as 'n staatsondersteunde, outonome liggaam saam met die Fakulteit sy onafhanklikheid kon gevier het nie. Dan sou die egskeiding na 'n huwelik wat reeds sy goue bruilof beleef het minder troumaties gewees het. Dan sou etlike logistiese probleme meer doeltreffend en ekonomies opgelos kon geword het. Hoe dit ookal sy, die probleme van praktiese logistiek staar die Fakulteit in die gesig en hulle moet en sal met die nodige goeie gesindheid opgelos word.

Die grondliggende probleem is een van finansies. Uit die sentralistiese aard van staatsbegrotingsmetodiek word daar eerder volgens kategorieë as volgens kleinere funksionele eenhede begroot. Binne die raamwerk van die geheel en binne sekere praktiese perke is dit baie eenvoudiger en doeltreffender. Maar dit bring mee dat niemand ooit geweet het presies hoeveel die Fakulteit die land jaarliks gekos het nie. En dit sou spanne kosteberekenaars geruime tyd geneem het om dit selfs by benadering te bepaal. Nou moet daar ineens bepaal word watter bedrag van die Departement Landbou-tegniese Dienste se gebruiklike begroting voortaan na die Departement Nasionale Opvoeding vir ondersteuning van die Fakulteit gekanaliseer moet word, laasgenoemde Departement tot dusver onbekend met die eienaardighede en eiesoortighede van 'n veeartsenykundige Fakulteit. Waar die Regering onder druk van openbare mening departementele begrotings drasties moes besnoei, kan 'n mens kwalik enige vrygewigheid verwag. Trouens, daar is al deur gesaghebbende instansies gewag

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appreciation and confidence, of a ministerial pronouncement that the change will in no way deleteriously affect the level of veterinary training. In one respect already this confidence has been shown not to have been misplaced: extra-ordinary steps have been taken by the Government to ensure that Faculty personnel, formerly officials of the Department of Agricultural Technical Services, will in no way suffer financial set-back as result of the change-over.

In the process of re-organization a number of services, centralized in the Institute, have become lost to the Faculty, such as photographic and work-shop services, as well as the supply of animals and animal material. Only a small portion of the latter can still be supplied, most of it upon payment according to set tariffs. For the rest, existing Treasury Regulations prohibit economic and efficient utilization of such services. Duplication is inevitable, with associated higher costs which eventually will have to come partly, if not wholly, from the State Coffers. One is also particularly concerned to what extent the invaluable collection of pathological material, assiduously built up over almost three-quarters of a century and constantly accruing to the Section of Pathology of the Institute, will be available to the Faculty. The matter is not so simple as it looks. The identical block of tissue may be required by both the Institute and the Faculty.

Fortunately, access to the Institute's Library with its unique collection has been retained. As result of economization, however, the Institute had to impose restrictions: since 1971 the acquisition of books concerning disciplines of less immediate concern to the Institute was curtailed; in 1972 this was suspended. Subscriptions of scientific journals less often consulted were ceased as from the end of 1972. It is hardly reasonable to expect the Institute to continue indefinitely with a number of others which it has been doing merely to assist the Faculty. Duplication of library services must come about: the main campus of the University is too far distant to supply the Faculty's needs. Unfortunately, financial provision for such duplication has been overlooked completely. We trust that this has been accidental.

*We calculate that, as a conservative estimate, it comes to R3 000 plus per student per annum. Of this amount the student pays just over 10 per cent in the form of class fees. A part could be defrayed from fees levied by the various clinics for services to the public.

Landbou-tegniese Dienste en van die Universiteit. Die groot vraag is of die onvermydelike hoë koste* verbonde aan 'n Fakulteit Veeartsenykunde wel in die opperste gesagskringe besef word. Daar is gelukkig 'n paar aanduidings dat dit wel die geval is. Met waardering en vertroue is kennis geneem van 'n ministeriële uitspraak dat die omskakeling geensins die peil van veeartsenykundige opleiding sal benadeel nie. Een deel van hierdie vertroue is reeds as nie misplaas bewys: buitengewone stappe is deur die Regering gedoen om te verseker dat die fakulteitspersoneel, voorheen amptenare van die Departement Landbou-tegniese Dienste, geensins deur die omskakeling finansieel benadeel sal word nie.

In die omskakeling het helaas 'n hele reeks in die Instituut gesentraliseerde dienste in die slag gebly, soos fotografiese dienste, werkswinkels, en verskaffing van diere en dieremateriaal. Slegs 'n geringe deel hiervan kan nog voorsien word, meesal teen betaling van bepaalde tariewe. Origens verhinder bestaande Tesourie-regulasies doeltreffende en ekonomiese benutting van sodanige dienste. Duplisering is dus onvermydelik, met gepaardgaande hoër koste, wat uiteindelik deels, indien nie ten volle nie, uit die Skatkis sal moet kom. 'n Mens is ook begaan tot watter mate die onskatbare versameling patologiese materiaal, ywerig byeengebring oor byna drie-kwart eeu, en steeds toevloeiende na die Seksie Patologie van die Instituut, tot die Fakulteit se beskikking gestel gaan word. Die saak is ingewikkelder as wat by eerste oogopslag blyk: die identiese blokkie weefsel mag deur beide die Instituut en Fakulteit benodig word.

Gelukkig het toegang tot die Instituut se biblioteek met sy waardevolle boekery vir die fakulteitspersoneel behoue gebly. Weens besnoeiing, egter, moes die Instituut noodgedwonge ook hier beperkings oplê: sinds 1971 is aankoop van wetenskaplike boeke t.o.v. bepaalde dissiplines waarby die Instituut minder belang het, ingekort; in 1972 is dit heeltemal opgeskort. Intekening op 'n aansienlike aantal wetenskaplike tydskrifte wat minder dikwels geraadpleeg word is vanaf einde 1972 gestaak. Daar kan kwalik verwag word dat die Instituut op etlike reek-

*Ons beraming is dat die koste, konserwatief gestel, R3 000 plus per student per jaar beloop. Hiervan betaal die student net oor die 10 persent in die vorm van klasgelde. 'n Verdere deeltjie is verhaalbaar uit gelde geïn deur die onderskeie klinieke vir diens aan die publiek.

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Much greater responsibility is now placed on the shoulders of members of Faculty: they will have to plan their budgets in minute detail. On the one hand it will have a salubrious effect: when one is fully aware what an item costs, one will tend to take greater care to use it sparingly. On the other hand, the additional administrative load might take an unjustifiable proportion of academic time. The Faculty of Veterinary Science, other than its sister Faculties of Medicine and Dentistry, cannot depend upon hospitals administered by public bodies, such as Provincial Administrations. In this respect a fairly wide-spread weakness in the South African 'industry of science' also becomes apparent: the lack of a properly recognized and trained administrative infrastructure to sustain the scientist.

A further serious hitch occurred inasmuch as a number of teachers and technicians, extremely competent and experienced persons amongst them, could not retain their faculty attachments. Suitable successors could not be found in every instance. In other cases, young and willing, but inexperienced, teachers had to take over after the first quarter of the academic year. (The change-over was scheduled to coincide with the departmental financial year.) Because of the large number of specialized disciplines to be taught in the Faculty, full responsibility for whole courses summarily devolved upon them, a procedure which normally would only have involved more experienced senior lecturers. Those posts which could not be filled immediately, had to be taken care of by temporarily seconded persons. Thus, also as far as teaching itself is concerned, there is going to be some crashing of gears before the Faculty gets fully under way. In the light of past experience, however, it may be assumed that the novices, with the courage, energy and idealism of youth, will compensate for initial lack of experience, and that they will even introduce an element of freshness, ingenuousness and ingenuity. To them a sincere word of welcome is extended; to those who have had to retire we tend our deep appreciation and thanks for their major contribution to the profession, to those who are still helping out, our gratitude for their selfless sacrifice.

se, wat nog goedgunstiglik terwille van die Fakulteit aangehou word, onbepaald sal bly inteken. Duplisering van biblioteekdienste sal moet kom; die universiteitsterrein is te ver om dit van daar te behartig. Helaas het finansiële voorsiening hiervoor heeltemal in die slag gebly. Ons vertrou dat dit slegs 'n glips was.

Groter verantwoordelikheid word nou op die skouers van die fakulteitspersoneel geplaas: hulle sal begrotings tot in die fynste besonderhede moet beplan. Enersyds sal dit 'n sanerende uitwerking hê: as 'n mens presies weet hoeveel 'n item kos, sal 'n mens spaarsamer daarmee omgaan. Andersyds mag die bykomstige administratiewe las 'n ongeregverdigde deel van dosente se tyd in beslag neem. Die Fakulteit Veeartsenykunde, anders as die susterfakulteite van Geneeskunde en Tandheelkunde, kan nie op hospitale staat maak wat deur openbare liggame soos Provinsiale Administrasies ge-administreer word nie. In hierdie opsig kom 'n vrywel algemene swakheid in die Suid-Afrikaanse wetenskapbedryf sterk na vore: die gebrek aan 'n behoorlik erkende en opgeleide infrastrukturele administrasiepersoneel om die wetenskaplike te onderskraag.

'n Verdere ernstige knelpunt is daarin geleë dat omstandighede etlike dosente en tegnici, daaronder hoogs bekwame en ervare persone, gedwing het om met uitlywing die fakulteitstuig neer te lê, terwyl daar nie in alle gevalle geskikte opvolgers gevind kon word nie. In ander gevalle, weer, moes jong en gewillige, maar onervare dosente na die eerste kwart van die akademiese jaar oorneem. (Die omskakeling moes saamval met die departementele finansiële jaar.) Weens die groot getal gespesialiseerde vakrigtings, het die volle verantwoordelikheid vir volwaardige kursusse summier op hul skouers beland, iets wat normaalweg eers met meer ervare senior lektore gebeur. Die poste wat nie dadelik beklee kon word nie, is deur tydelike sekondering van beamptes van die Instituut gevul. Daar sal dus onvermydelik in die begin ook t.o.v. dosering 'n gekrap van ratte wees voor die Fakulteit in volle beweging kom. Maar in die lig van ervaring in die verlede, kan aanvaar word dat die nuwelinge met die besondere moed, dryfkrag en idealisme van die jeug vir eers sal vergoed vir aanvanklike ervaringsgebrek, hul voete wel sal vind en selfs 'n frisheid, onbevangenheid en vindingrykheid sal inbring. Aan

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Serious problems of adequate space have arisen, because four of the nine Faculty Departments are still housed at the Institute, no provision as yet having been made on the Faculty Campus. Only if and when this has been done satisfactorily, will the Faculty in its present form be organized properly to take its present quota of 45 new students per year.

Exploration for sources of subvention for research are now apparently wide open; such sources include the Department of Agricultural Technical Services. Time will teach to what extent these soures will be adequate. As yet, no problems are foreseen.

A potential psychological danger must be realized. Where two groups have become divided so distinctly, factionalism can easily rear its head: man remains in effect a territorial animal. The temptation will be great to ascribe some occurrences to the sinister motives of 'the other party' and to give rein to emotions and rash statements instead of exercising care and proper understanding. The road separating the Institute from the Faculty has already been referred to jocularly as 'the tar curtain' and the intersection thereof with the road connecting the two as "Checkpoint Charlie". Due care will have to be taken that jest does not become earnest.

As far as members of Faculty are concerned, there is every indication that the challenges are going to be met fearlessly. In spite of tremendous administrative pressure, the Faculty still has found time to plan for, a) extension of the course from five to five-and-a-half years, with incisive internal reorganisation and emphasis on integration of knowledge during the last two semesters, especially with regard to preventative medicine and the herd and species approach, b) the innovation of a Diploma course in Animal Nursing, and c) doubling of the number of entrants to the course from 45 to 90 per annum. All these plans had to be put aside, because the Van Wyk de Vries Commission, appointed to determine the formula for State subvention of universities, will not have completed its task for some considerable time.

hulle dus 'n hartlike woord van welkom, aan die uittredendes 'n opregte woord van dank en waardering, aan die uithelpers ewe-eens 'n besondere dankwoord vir hul onbaatsugtige opoffering.

'n Ernstige ruimtelike probleem het ontstaan deurdat vier van die nege departemente nog by die Instituut gehuisves word. By die fakulteitskampus is daar geen voorsiening vir hulle gemaak nie. Eers as dit bevredigend gedoen is, sal die Fakulteit behoorlik ingerig wees om sy huidige kwota van 45 studente per jaar in te neem.

Potensiële bronne vir navorsingondersteuning lê nou oënskynlik wawyd oop en sluit die Departement Landbou-tegniese Dienste in. Ervaring sal moet leer tot watter mate die bronne in die Fakulteit se behoeftes sal kan voorsien. Voorasnog word geen probleme voorsien nie.

Een psigologiese potensiële gevaarpunt moet terdeë in ag geneem word. By so 'n duidelike verdeling in groepe kan faksionalisme maklik kop uitsteek: die mens bly maar 'n territoriale dier. Die versoeking sal groot wees om bepaalde gebeure aan sinistere motiewe van „die ander party" toe te dig en om emosionaliteit en ondeurdagte stellings te laat seëvier in plaas van versigtig deurdagte begrip. Daar is al spottenderwys na die teerpad wat die Instituut van die Fakulteit skei as die „teergordyn" verwys, en na die kruispunt hiervan en die verbindingspad tussen die twee inrigtings as „Checkpoint Charlie". Ons sal moet waak dat dié skerts nie erns word nie.

Wat die fakulteitspersoneel betref is daar bemoedigende tekens dat die uitdagings vreesloos aanvaar gaan word. Ten spyte van geweldige administratiewe werksdruk wat die herorganisasie teweeggebring het, het die Fakulteit nogtans tyd gevind om te beplan vir, a) die verlenging van die kursus van vyf na vyf-en-'n-half jaar, met ingrypende interne reorganisasie en klem op integrasie van kennis gedurende die laaste twee semesters, veral t.o.v. voorkomende geneeskunde en kudde- en spesiesbenadering, b) instelling van 'n diplomakursus in Diereverpleegkunde, en c) die verdubbeling van getal studente ingeneem van 45 na 90 per jaar. Al hierdie planne is voorlopig ter syde gestel, omrede die Van Wyk de Vries-kommissie, wat die formule vir universiteitsubsidiëring deur die Staat moes bepaal, sy werksaamhede vir nog geruime tyd nie afgehandel sal hê nie.

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Such is the picture: a magnificent challenge for the courageous. The South African Veterinary Association trusts that the members of Faculty — and that includes all ranks — will comply with the demands made on them and that the various authorities in their difficult task of determining priorities will not leave a small but important Faculty in the lurch. As a profession that has always regarded service as its first task, we can only be satisfied with the very best from the Faculty.

So lyk die prentjie: 'n pragtige uitdaging vir die wat moed het. Die SAVV vertrou op lede van die Fakulteit — en dit sluit alle range in — om aan die hoogste eise te voldoen, en op die onderskeie owerhede, dat hulle in hul moeilike taak van prioriteitsbepaling 'n klein maar uiters belangrike fakulteit nie in die steek sal laat nie. As professie wat nog altyd diens as eerste opdrag gestel het, kan ons slegs met die allerbeste by die Fakulteit tevrede wees.

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REDAKSIONELE AANTEKENING

UNISA-EEUFEES*

In ouderdom slegs 'n tienderjarige vergeleke by die ouer Europese universiteite, vier die Universiteit van Suid-Afrika — die land se oudste inrigting vir tersiêre onderwys — vanjaar sy eeufees. Op een of ander wyse is UNISA die *Alma Mater* van alle Suid-Afrikaanse universiteite, met uitsondering van die jongste twee aankomelinge: die Universiteit van Port Elizabeth en die Randse Afrikaanse Universiteit. Die eerste ses groepe graduandi van die Fakulteit Veeartsenykunde het hul grade deur die Universiteit van Suid-Afrika behaal.

UNISA is in 1873 gestig as die Universiteit van die Kaap die Goeie Hoop, op die patroon van die Universiteit van Londen. Dit was 'n suiwer eksaminerende liggaam, ter vervanging van die Raad van Openbare Eksaminatore, wat dit sinds 1858 voorafgegaan het. In 1906 het die Universiteit sy eerste ware tuiste gekry, 'n indrukwekkende gebou in Queen Victoriastraat, Kaapstad, wat nou die Kaapse Argief huisves. Ooreenkomstig Wet 12 van 1916 is die Universiteit se naam op 2 April 1918 na sy huidige vorm verander. Twee van die mees gevorderde kolleges van daardie tyd, en UNISA se pleegkinders, het toe as volwaardige, onafhanklike

*Feitemateriaal goedgunstiglik verskaf deur mnr. N. C. van Ryneveld, Eeufeessekretaris, Unisa.

EDITORIAL NOTE

UNISA CENTENARY*

In terms of age but a teen-ager compared to Europe's older universities, the University of South Africa — the country's oldest institute of higher learning — celebrates its centenary this year.

In one sense or another UNISA is the *Alma Mater* of all south African universities, except the two most recent arrivals on the scene: the University of Port Elizabeth and the Rand Afrikaans University. The first six groups of graduates of the Faculty of Veterinary Science were granted their degrees by the University of South Africa.

UNISA was founded as the University of the Cape of Good Hope in 1873 on the pattern of the University of London. It was purely an examining body in the place of the Board of Public Examiners, which had preceded it since 1858. In 1906 the University obtained its first real home in an impressive building in Queen Victoria Street, Cape Town, which now houses the Cape Archives. In terms of Act 12 of 1916 the University's name was changed on 2 April 1918 to that of the University of South Africa. The two most advanced colleges at that time, and the University's academic wards, emerged as the in-

*Factual material kindly supplied by Mr. N. C. van Ryneveld, Centenary Secretary, Unisa.

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universiteite, dié van Kaapstad en dié van Stellenbosch ontstaan.

Pretoria, die Jakarandastad en administratiewe hoofstad van die agtjaar-oue Unie van Suid-Afrika, het die Universiteit se nuwe setel geword. Ses (later sewe) konstituerende kolleges met gemeenskaplike leerplanne en grade het die federale Universiteit gevorm, wat self ook eksamens van private (buitemuurse) studente afgeneem het. Een na die ander het die universiteitskolleges die moeder se nes verlaat en onafhanklike universiteite geword: Witwatersrand in 1920, Pretoria in 1930, Natal in 1949, Oranje-Vrystaat in 1950 en Rhodes en Potchefstroom in 1951. Ten opsigte van die ontwikkelende drie Bantoe-universiteitskolleges, die eén Kleurling- en die eén Asiate-universiteitskollege, het die Universiteit van Suid-Afrika sy rol voortgesit, totdat hulle ook in 1970 onafhanklike status verkry het.

Ondertussen is 'n Departement vir Eksterne Studies in 1946 gestig, wat opleiding aan buitemuurse studente deur middel van die geskrewe woord aangebied het, met behulp van die akademiese personeel van die konstituerende kolleges. (Al die universiteite in Suid-Afrika was op die Raad en Senaat verteenwoordig). Dit het daarop uitgeloop dat die Universiteit as 'n suiwer eksterne universiteit herorganiseer is, geratifiseer deur parlementêre wetgewing in 1951. Sy verdere ewolusie in hierdie rigting was 'n natuurlike reaksie op die noodsaak vir intellektuele ontwikkeling in 'n land met 'n snel gedyende ekonomie. Koördinering van die dringende behoefte aan gekwalifiseerde mannekrag met die fundamentele reg van die mens op hoër geesteslewe en ooreenstemmende hoëre opleiding moes ekonomies bewerkstellig word in die aangesig van die uitgebreidheid van die land, baie dele vér afgeleë van hoëre opvoedingsentra, en van die heterogeniteit van sy bevolking.

Die fenomenale groei en sukses van hierdie ontwikkeling is gekenmerk deur verdere mylpale. Teen 1962 is dit bepaal dat studente wat vir eksamen inskrywe ook vir opleiding moet registreer. In 1967 het die *Alma Mater* op haar beurt haarself losgemaak van die regie van haar dogters: deur Wet 53 van 1967 is verteenwoordiging van ander universiteite op die Raad en Senaat van die Universiteit van Suid-Afrika afgeskaf.

Noodhulpbehuising is in 1954 gedeeltelik vervang deur 'n administratiewe gebou en in 1959 deur 'n biblioteekgebou, beide slegs om

dependent University of Cape Town and Stellenbosch respectively.

Pretoria, the Jacaranda City and Administrative Capital of the eight-year-old Union of South Africa, became the University's new seat. Six (later seven) constituent colleges with common syllabuses and degrees formed the federal University, which itself also continued to conduct examinations for private (external) students. One after another the university colleges left the maternal nest to become independent universities: Witwatersrand in 1920, Pretoria in 1930, Natal in 1949, Orange Free State in 1950, Rhodes and Potchefstroom in 1951. The University of South Africa continued its rôle vis-á-vis the developing three African university colleges, as well as the Coloured and the Asiatic college, until 1970, when they, too, attained independent status.

Meanwhile a Department of External Studies had been initiated in 1946, offering tuition to external students through the specialized medium of the written word, with the help of the academic staffs of the constituent colleges. (All the universities in South Africa were represented in the Council and Senate). This initiation evolved into the University being re-organized into a purely external university, ratified by Act of Parliament in 1951. Its further evolution in this direction was a natural response to the need of intellectual development in a country with a rapidly expanding economy. Co-ordination of the urgent demand for qualified man-power with the fundamental right of man to a higher spiritual life and corresponding higher education had to be effected economically in the face of the vastness of the country, remoteness of many parts from centres of higher education and heterogeneity of its population.

The phenomenal growth and success of this development were marked by further milestones. By 1962 it was decreed that students wishing to enter for examination should also register for tuition. By 1967 the *Alma Mater* loosened herself from the tutelage of her daughters: by Act 53 of 1967 representation of other universities in the Council and Senate of the University of South Africa was abolished.

Make-shift housing was partially replaced by an administration building in 1954 and a library in 1959, both soon to be expanded. But the Magician's Apprentice had spoken

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spoedig uitgebrei te word. Maar die Towenaar se Leerjonge het die spreuk gespreek en die Universiteit het in enige holtetjie ter hand oorgesuurdeeg, van gewese private hotelle tot banke. Uiteindelik is 'n terrein van 40 akker op Muckleneukheuwel aan die suidelike toegangspoort van die stad deur die Stadsraad van Pretoria geskenk. Hier het 'n gebou verrys wat „in die ruimte inskiet... skynbaar liggies in die lug gebalanseer" waar die grootste inrigting van sy soort ter wêreld die intellektuele bevordering van nagenoeg 30 000 studente van alle nasies, rasse en gelowe, van alle uithoeke van die aardbol, behartig. Hierdie gebou is offisieel op 14 April 1973 deur die Staatspresident geopen.

Die doserende personeel beloop ongeveer 530 en die administratiewe personeel 600. Die studente se ouderdomme wissel van 16 tot 78, met 'n mediaan tussen 25 en 30. Die getal nagraadse studente beloop 16,1 persent van die studentetal. Aan die einde van 1972 is nie minder nie as 748 eksamensentra gebruik om eksamenkandidate te akkommodeer, van die V.S.A. in die weste tot Thailand en Australië in die ooste.

Die stelsel van teletuïsie is tot 'n fyn kuns ontwikkel en die gaping tussen dosent en student vernou deur gebruik te maak van uitvoerige kommentaar op studente-take, onderrigbriewe, vorming van studiegroepe in sentra met grotere studentetalle, persoonlike onderhoude en briewe, die hou van vakansieskole en verskaffing van tegnologiese hulpmiddels. Teen klasgelde van R30 per onderwerp per jaar en 'n registrasiefooi van R10 is die Universiteit waarskynlik die doeltreffendste van sy soort in terme van koste aan die student.

Die Instituut vir Buitelandse en Vergelykende Reg, die Skool vir Bedryfsleierskap (deur kenners beskrywe as die mees nuwigheidinvoerende ter wêreld) en die Buro vir Universiteitsnavorsing, is 'n paar gespesialiseerde institute van die Universiteit.

Gedurende die eeufeesjaar is etlike kongresse, simposia en ander funksies beplan, insluitende die Simposium oor Wildbewaring en benutting (4—8 Junie) en die Kongres van die SAVV (15—19 Oktober).

Die Suid-Afrikaanse Veterinêre Vereniging bied hiermee sy hartlikste gelukwense aan die Universiteit van Suid-Afrika by die bereiking van sy eerste eeu en wens dit opreg alle sukses toe in sy skitterende diens aan die volkere van Suidelike Afrika en van die wêreld.

the word and the University overflowed into anything at hand, from private hotels to banks. Eventually a 40 acre site on Muckleneuk Hill at the southern entrance to the city was donated by the City Council of Pretoria. Here an edifice has arisen "leaping into space... seemingly balanced lightly on air", where the largest institution of its kind concerns itself with the intellectual advancement of approximately 30 000 students of all nationalities, races and religions from all corners of the globe. This building was officially opened by the State President on April 14, 1973.

The teaching staff numbers about 530 and the administrative personnel 600. The students' ages range from 16 to 78, with a median between 25 and 30. Post-graduate students comprise 16,1 per cent of the student body. At the end of 1972 no fewer than 748 examination centres were used to accommodate candidates sitting for their examinations, from the U.S.A. in the west to Thailand and Australia in the east.

The system of teletuition has been developed to a fine art and the gap between lecturer and student is being bridged by extensive comment on students' assignments, tutorial letters, formation of study groups in centres with fairly large numbers of students, personal interviews and letters, holding of vacation schools and supplying technological aids. At a tuition fee of R30 per subject per annum and a registration fee of R10 the University would probably constitute one of the most efficient of its kind in terms of cost to the student.

The Institute of Foreign and Comparative Law, the School of Business Leadership (described by experts as the most innovational in the world) and the Bureau for University Research represent some of the specialized institutions within the University.

During the centenary year numerous congresses, symposia and other functions have been scheduled, including the Symposium on Wildlife Conservation and Utilization (June 4—8) and the Congress of the SAVA (October 15—19).

The South African Veterinary Association extends its heartiest congratulations to the University of South Africa on attaining its hundredth anniversary and sincerely wishes it every success in its magnificent service to the nations of Southern Africa and of the world.

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REVIEW

OORSIG

METABOLIC AND FUNCTIONAL PROPERTIES OF SKELETAL MUSCLE IN RELATION TO MEAT QUALITY*

J. J. A. HEFFRON**

INTRODUCTION

The present review of muscle metabolism is a summary of recent developments in the biochemistry and physiology of skeletal muscle and of metabolic aberrations occurring in the musculature of meat-producing animals. The significance of the biochemistry and physiology of skeletal muscle in the present context lies in the fact that muscle is transformed into meat after completion of the biochemical changes leading to *rigor mortis*. The review is not intended as an exhaustive study of the literature on the subject. Most of the complex mechanisms in muscle metabolism will be simplified as it is beyond the scope of this paper to evaluate the detailed evidence for any particular mechanism. This permits presentation of much of the biochemical knowledge essential to an understanding of the influence of the physiological status of the live animal on the time-course of *post-mortem* metabolism in the skeletal musculature. It is assumed that the rate and extent of *post-mortem* muscle metabolism determine the quality of the meat which may be derived. A basis is thereby provided for a better understanding of the manner in which stress, in its several forms, affects the metabolism of the animal, and the intrinsic physiological systems which enable the animal to accommodate stress. It is appropriate, then, to start with a description of the structural organisation of skeletal muscle, leading to a discussion of excitation-contraction coupling and relaxation, muscle fibre classification and development, the metabolic pathways supplying energy for activity, and the hormonal integration of these pathways. A brief description of the metabolic changes occurring in domestic animals owing to stress and intensive selection for high growth rate will follow. Finally, the relation between accelerated metabolic rates in skeletal muscle and the potential meat quality of the muscle will be described.

Before turning to the structure and function of skeletal muscle it must be emphasized that most of the pertinent knowledge has been obtained from experiments conducted on laboratory animals, e.g. frog, mouse, rat and rabbit. Bearing this in mind, care should be exercised in extrapolating results from these animals to the various domestic species.

STRUCTURAL ORGANIZATION OF SKELETAL MUSCLE

Muscle, in its three forms, skeletal, cardiac and smooth, is a highly and specifically organized tissue, both biochemically and morphologically. Functionally it is designed for energy production and its conversion to mechanical motion and work. In many respects muscle can be compared with a typical modern machine though it differs in some important aspects, namely, muscle is capable of automatic repair and maintenance, whilst at the end of its life it is both edible and nutritious [1]. Basic studies since the beginning of the century have partially unravelled the intricate biochemical pathways of metabolism and the mechanisms of contraction and relaxation in skeletal and cardiac muscle [2]. Smooth muscle has received little attention but as techniques improve it becomes apparent that it is qualitatively similar to skeletal muscle, though structurally less highly organized.

The basic unit of a muscle, the fibre, is shown at various levels of organization in figure 1. A whole muscle is composed of many thousands of individual cells held together by several connective tissue sheaths. Interspersed between the fibres are the blood vessels and the axon branches of the nerves innervating the muscle. The fibre is a long cylindrical cell varying in diameter from about 20 to 100 μm in the adult animal and having a fine covering of connective tissue, the endomysium. Fibre bundles are formed by lateral aggregation of several fibres within the perimysium. Continuity of the fibres with the tendons is effected by the outer-

*Lecture delivered at the Animal and Dairy Research Instiute, Irene, on June 21st, 1972.

**Animal and Dairy Science Research Institute, Irene. Request for reprints to be directed to the Director. Author's present address: Dept. of Physiological Chemistry, Medical School, Hospital Street, Johannesburg.

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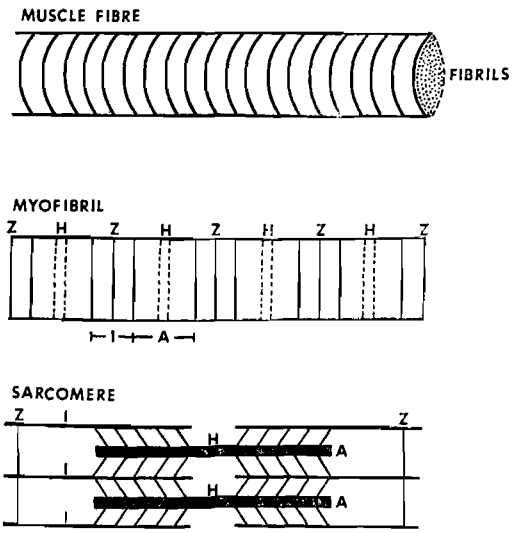

Fig. 1: The skeletal muscle fibre at different levels of structural organization, described in the text.

most connective tissue sheath, the collagen fibrils of which anastomose with those of the tendons. Muscles vary enormously in their number of fibres: from several hundred in the frog *M. sartorius,* hundreds of thousands in the *M. longissimus dorsi* of the pig and probably several millions in that of the sperm whale. It is generally accepted that fibres constitute between 75 and 90% of a muscle, variation being due largely to species differences.

The muscle fibre itself is enclosed in a membrane, the sarcolemma, within which are myofibrils, whose specific property is contractility. The myofibrils occupy the major part of the fibre volume: they are strands 1—2 μm in diameter, which may be as long as the fibre itself and consisting of filaments of the two proteins, myosin and actin. The myofibril possesses alternate dark and light bands when viewed by the phase-contrast or electron microscope. The dark and light bands, known as A- and I-bands, are composed of filaments of myosin and actin, respectively. In the centre of the A-band is a light area known as the H-zone whilst in the centre of the I-band is a dark line known as the Z-line. The minor protein components of the myofibril, tropomyosin, troponin and the actinins may be constituents of the Z-line as well as being distributed along the filaments of the I-band[3, 4]. At the junction of the A- and I-bands the two types of filament overlap in a double hexagonal array. The myofibril itself is comprised of a longitudinally repeating unit, known as the sarcomere which extends from one Z-line to the next. In the region of overlap of the A- and I-filaments there exist cross linkages between the filaments. Contraction is believed to involve the sliding of the I-filaments past the A-filaments into the H-zone, thus effecting the over-all shortening of the myofibril[5].

The sarcolemma of mammalian muscle is invaginated at the level of the A—I junction of each sarcomere; the membranes formed by invagination extend completely across the cell interior, and are in direct contact with the filaments of the myofibrils. These membranes, known as the transverse tubules, are in direct morphological continuity with the sarcolemma in from muscle[6, 7] and in fish myotomes[8]. Adjacent to the transverse tubules, on both sides at the A—I junction, are dilated vesicles called the terminal cisternae. Further morphologically distinct vesicles extend from the terminal cisternae to the centre of the A-band[7]. All of these intracellular membranes form what is best known as the sarcoplasmic reticulum, and are part of the relaxation system of muscle. Mitochondria are usually interspersed between the myofibrils, their density depending on whether the muscle is red or white. The high oxidative-metabolic activity of red muscle is due primarily to the greater mitochondrial content, whereas white muscle has a low mitochondrial content and, consequently, a very poorly developed oxidative metabolism.

Unlike most other cells, the muscle fibre is multinucleate, the nuclei being distributed peripherally, close to the sarcolemma. All of the formed elements of the muscle fibre are bathed in a watery fluid, the sarcoplasm, which contains the glycolytic enzymes and other soluble muscle proteins.

CONTRACTION-RELAXATION CYCLE

A complete contraction-relaxation cycle can now be described taking into account the morphological and biochemical evidence available at present. When the nerve impulse arrives at the motor endplate, it initiates a wave of depolarisation which spreads down the fibre, and enters the fibre passively via the transverse tubular membranes. The ionic current passing through the latter is carried by Na^+ ions. This occurs at the initial stage

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of the action potential, whilst K^+ ions enter the transverse tubules at a later period of the action potential. In essence this is the first step of excitation-contraction coupling. This depolarisation is believed to cause release of Ca^{2+} ions from the terminal cisternae of the sarcoplasmic reticulum though the mechanism whereby it effects release of Ca^{2+} ions is unknown as yet. The Ca^{2+} ions react with the proteins troponin A and B which control the myosin-actin interaction [9]. In some manner, as yet obscure, the reaction of Ca^{2+} ions with the troponins removes the inhibitory effect of the latter on the myosin-actin interaction. Chemical interaction between the myosin cross-bridges and actin then takes place in the presence of ATP. The interaction, which has an absolute requirement for Mg^{2+} ions, hydrolyses ATP to ADP and inorganic phosphate, releasing the energy necessary for the conformational changes of the myosin cross-bridges to take place. The direction of cross-bridge movement is towards the centre of the A-band so that the actin filaments of each half sarcomere are drawn to the centre of the A-band of the same sarcomere. It is the shortening of each sarcomere in this manner along the length of the fibre that results in the over-all shortening of the muscle. Contraction is quickly followed by repolarisation of the sarcolemma and transverse tubules, and relaxation is brough about by the active sequestration of Ca^{2+} by the sarcoplasmic reticulum. Relaxation is said to be an "active" process, since it requires energy in the form of ATP. Relaxation is complete when the intracellular Ca^{2+} concentration has been reduced to 10^{-7}M [10, 11].

ENERGY SOURCES

The preceding account of the contraction-relaxation cycle mentioned that the source for both contraction and relaxation is ATP. Several detailed studies with frog muscle have shown that ATP is the most immediate source of energy for contraction [12-14]. ATP is also necessary to maintain the relaxed state, a function commonly referred to as its plasticising action, i.e. it enables the myosin and actin filaments in the resting muscle to slide freely past one another without the formation of contraction bonds. ATP is also necessary for the maintenance of the irritability and permeability of the sarcolemma. The supply of ATP for these processes is provided by any combination of three main systems and, to a lesser extent, through the enzyme myokinase, depending on the level of muscular activity, as outlined in figure 2. The most immediate energy requirements in fast-acting white muscle are met by phosphocreatine which is converted to ATP by the enzyme creatine kinase (CK) as follows:

$$\text{PHOSPHOCREATINE} + \text{ADP} \underset{}{\overset{\text{CK}}{\rightleftharpoons}} \text{CREATINE} + \text{ATP}$$

and by glycolysis. In slow-acting red, as in cardiac muscle, with its abundant mitochondria and blood supply, ATP is generated by oxidation of acetyl-CoA in the Krebs cycle. The myokinase enzyme system may be regarded as a terminal one and is likely to operate only under conditions of intense activity and high work load. On a molar basis the oxidative reactions are 12 to 18-fold more efficient than the glycolytic reactions in generating ATP. It is the efficiency of oxidative metabolism that confers upon red muscle its capacity for sustained activity.

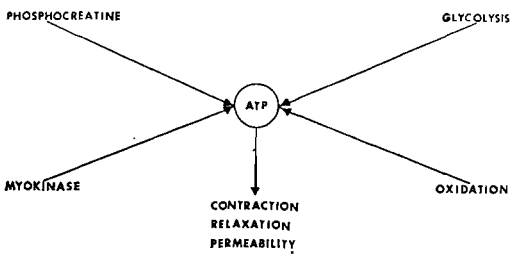

Fig. 2: Metabolic sources and function of ATP in skeletal muscle.

The above-mentioned energy supply systems operate *in vivo* but after death the Krebs cycle reactions can no longer take place owing to absence of oxygen. The initial ATP supply is provided by phosphocreatine which is quickly degraded *post mortem*. Further ATP is generated by anaerobic glycolysis, and finally as the ADP level increases the last ATP is formed via the myokinase enzyme. During the depletion of ATP the onset of *rigor mortis* commences. When virtually all of the ATP has been consumed, the cross-bridges of myosin bind firmly to the actin filaments, so that they can no longer slide freely past one another. It is important to note that cross-links form only where filament overlap occurs. The formation of these cross-links causes a large increase in the modulus of elasticity of muscle [15] manifesting itself as an increase in the rigidity of what was formerly a supple, living muscle.

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RIGOR MORTIS

Although the characteristics of the phenomenon of *rigor mortis* have been known since the earliest times, it is only recently that the basic biochemical changes leading to *rigor mortis* have been elucidated. The primary physical characteristic of *rigor mortis* is the rigidity or inextensibility of the muscles owing to the firm binding of the actin to the myosin filaments in each sarcomere of the muscle fibres. The development of *rigor mortis* commences when the ATP level in the cell has fallen to about 2 μmoles per gram of muscle due to the action of muscle ATPase.

Three types of *rigor* have been recognized:

(a) acid *rigor* which occurs in immobilized or struggling animals;
(b) alkaline *rigor* which occurs in exhausted animals, where there is no lactate produced because of the absence of glycogen;
(c) an intermediate type of *rigor*, occuring in starved animals, where there is some lactate produced.

The type of *rigor* which will occur is strictly determined by the initial levels of phosphocreatine, ATP and glycogen in the musculature [16]. It is important to note that the degree of shortening occurring during *rigor* is highly temperature-dependent, none occurring at 17°C and about 15% at 37°C. Furthermore, *rigor* contraction develops only a very small fraction of the power developed during physiological contraction. The importance of the contraction associated with *rigor mortis* in the present context is dealt with later.

CLASSIFICATION OF SKELETAL MUSCLE FIBRES

Reference has already been made to fast- and slow-acting muscle, the two types being differentiated by their energy supply systems. Since about the beginning of this century, metabolic and functional differences have been recognized between red and white muscle, white muscle being capable of rapid, brief contractions and utilizing glycolysis for energy production, whilst red muscle undergoes sustained contraction and relies on oxidative metabolism for its energy supply. Many studies in the past decade have shown that a muscle fibre classification based on white muscle being fast and anaerobic and red muscle being slow and aerobic was too simple, since many exceptions to this so-called rule existed.

More precise modern fibre classifications are based on biochemical, physiological and enzyme histochemical criteria. The myosin and actomyosin adenosinetriphosphatase (ATPase) activities of proteins from widely different muscles have been shown to be correlated linearly with contraction velocity over a wide range [17]. It is now well accepted that the rate-limiting step in muscular contraction is the rate of ATP hydrolysis by myosin ATPase. There are several muscle fibre classification systems based on data concerning enzyme histochemistry. Some workers [18, 19] recognized two main fibre types: type I having high dehydrogenase and low phosphorylase activities and type II having high phosphorylase and low dehydrogenase activities. Fibres with intermediate enzyme activities were also noted. Three fibre types, A, B and C have been recognized on the basis of intensity of staining for succinic dehydrogenase [20]. The A fibre represents the classical white fibre whilst B and C represent two forms of red fibre. More recent studies [21, 22] have shown that there are three principal fibre types as illustrated in figure 3.

(i) White fibres with relatively short isometric contraction times, high myosin ATPase and glycolytic enzyme activities, low mitochondrial content and oxidative enzyme activity.

(ii) Red fibres with relatively short isometric contraction times, high myosin ATPase activity, moderate levels of glycolytic enzyme activities, many mitochondria and high oxidative enzyme activity.

(iii) Intermediate fibres with low-speed of contraction and myosin ATPase activity, low glycolytic enzyme activity, high mitochondrial content and oxidative enzyme activities.

This classification does not mean that all fibres of a particular metabolic type have the same contractile properties in different muscles of the same animal. Red and white muscles are not homogeneous with respect to the type of fibre but are composed of various proportions of red, white and intermediate fibres. It may be said that the metabolism of a muscle is that of the predominant fibre type. An exception to the rule is the *M. psoas* of the rabbit which has been reported to have white fibres only [23]. The soleus

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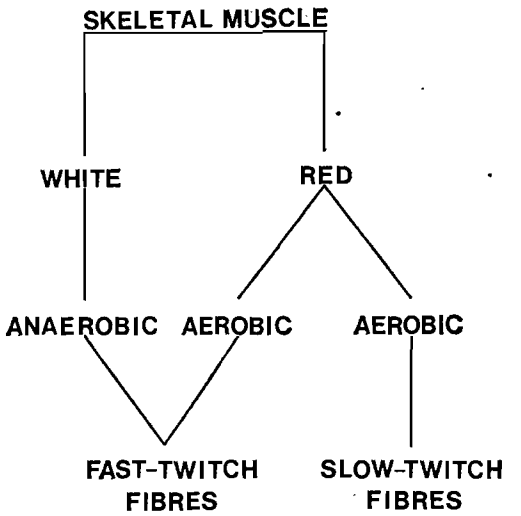

Fig. 3: Classification muscle fibres on basis of metabolic type and speed of contraction.

muscle has always been considered to be a red muscle but recent studies show that in the cat and guinea-pig it is composed entirely of intermediate fibres [21, 24]. In the rat and pig the *M. semitendinosus* is divided into two distinct red and white bands, clearly visible with the naked eye [25, 26].

Recently several investigators have shown that the nerve supply plays an important rôle in determining muscle fibre type. It is possible to change the biochemical and histochemical properties of a muscle by reversing the innervation [27-29]. The effect may be due to a direct trophic action of the nerve on the muscle or to the nature of the contractile pattern induced by the firing action of the motoneurone.

FIBRE DEVELOPMENT

The size of muscle fibres in various species of farm and laboratory animals has been found by several authors [30-34] to increase with age, whilst the number of fibres in a given mammalian muscle appears to remain constant after birth. Great differences in fibre size occur between the same muscle in different species, and between different muscles in the same species. In all of the mammalian species examined, it appears that muscles have uniformly slow contraction times at birth. In the initial stages of development the isometric twitch contraction times are about the same for all muscles in a given animal species; further development produces faster responses and the contraction times decrease to adult values concomitant with the differentiation into fast and slow fibres [35]. This differentiation is complete within a few weeks postnatally. Also, differentiation into fast and slow muscle takes place at different times during ontogeny, depending on the maturity of the species at parturition. In the sheep, fibre differentiation occurs mainly during the pre-natal stages whilst in the cat it is spread over the late pre-natal and early post-natal periods [35, 36]. Fibre development in rodents is mainly post-natal [37], as in the pig [38]. A recent report [39] indicates that bovine muscles assume adult appearance by the end of gestation, although the fibres are much smaller than in the adult. Human muscles follow the same pattern [40]. These observations suggest that the time-course of maturation of fibre types may be explained by the duration of gestation of the animal species.

Only a limited amount of information is available on the effect of hormones on muscle fibre growth [41]. Present evidence indicates that the growth of different muscles is controlled by different hormones and at different levels such as transcription and translation [42]. Apparently somatotrophin is necessary for the normal growth of muscle fibres but not for fibre hypertrophy, which is work-induced [43].

HORMONAL INTEGRATION OF METABOLISM

The metabolism of skeletal muscle is integrated with that of the rest of the organism by the levels of various hormones in the circulation as well as in the neural system. The actions of the hormones are illustrated in figure 4. Insulin and epinephrine are the hormones of greatest importance in muscle metabolism, the former promoting glycogen formation in muscle and liver and the latter promoting its breakdown. Blood glucose is increased by adrenocorticotrophic hormone (ACTH), glucagon, growth hormone and cortisol, as well as epinephrine, although not by the same mechanism. Glucose homeostasis depends primarily upon the action of insulin, but, under conditions of activity or stress epinephrine initiates a regular sequence of reactions to cope with the increased energy demands. This typical reaction has been called "the general adaptation syndrome" by its discoverer, Hans Selye [44]. Adaptation to stress in its manifold forms, under which activity may be included, is accomplished by the sequential action of epinephrine, cortisol and

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11-deoxycorticosterone. The hypothalamus is of central importance in co-ordinating the manifold equilibria concerned with adaptation to stress and maintenance of homeostasis. The circulating levels of the glucocorticoids participate in a sensitive feedback system with hypothalmic corticotrophin-releasing factor. Stress is then accommodated by the hypothalamus, pituitary and adrenal glands operating in concert. The hormones restore the energy levels and cell potassium to the resting equilibrium values. As long as this mechanism is adequate to cope with the intensity and duration of the particular stressor, the animal adapts, but where they are too great, the hormonal system collapses and so-called adaptational disease sets in.

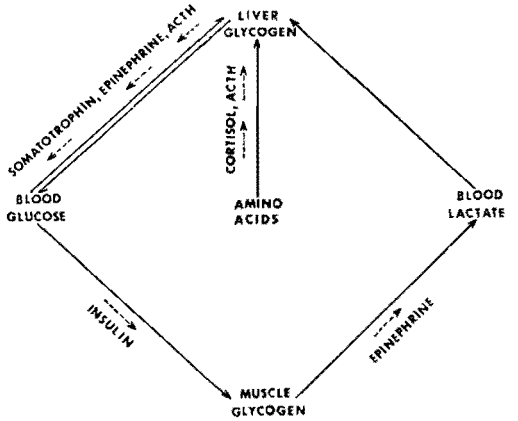

Fig. 4: Outline of hormonal integration of metabolism in relation to skeletal muscle. Broken arrows indicate the direction of the promoting effect of the hormones on the metabolic reactions.

ABERRANT MUSCLE METABOLISM

Diseases of muscle will not be dealt with under this heading since several excellent, detailed treatises are available [45-47]. For the purpose of this review attention is focussed on the development of an aberrant metabolism in the musculature of the pig. The modern, muscular **pig**, a product of intense selection over many years for high growth rate and increased total muscle mass, is particularly prone to stress (Figure 5). Such breeds as the Pietrain, Landrace and Poland China are particularly stress-susceptible [48-51]. Stress-susceptibility is associated with a highly accelerated metabolism, metabolic acidosis and over-production of lactate in the skeletal muscles. Stress-susceptible animals develop tachycardia and the respiratory rate increases during the first ten minutes of heat stress [52]. A malignant hyperthermia, which has been attributed to an uncoupling of

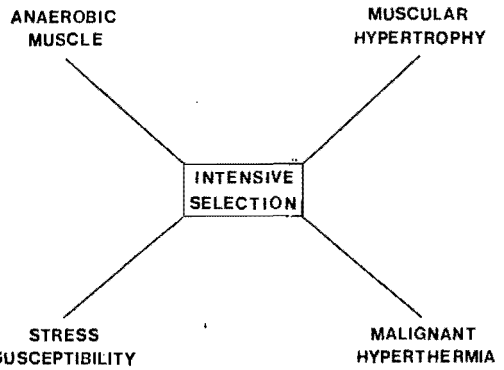

Fig. 5: Diagram to illustrate the changes occurring in pigs selected for high growth rate and total muscle mass.

oxidative phosphorylation or blood acidosis, follows [53]. Skeletal muscle from stress-susceptible animals exhibits a rapid *post-mortem* glycolysis and results in a typically pale, soft and exudative musculature. The condition of pale, soft, exudative muscle in pigs has been described as a pathological one by some authors [54, 55]. It has been proposed that the presence of "giant" fibres in the muscles of stress-susceptible animals may be indicative of a pathological change in the muscle [56]. Further work did not show evidence of changes associated with true muscular dystrophies [57], and it has been suggested that a pathological description of the condition is inappropriate since it only manifests itself *post-mortem* [58]. The syndrome of malignant hyperthermia occurs in certain strains of Landrace pigs when exposed to the volatile anaesthetic halothane [51, 59, 60]; it has been suggested that stress-susceptibility, the pale, soft, exudative muscle condition and malignant hyperthermia are all manifestations of the same basic myopathy [61]. At present it is unclear whether stress-susceptibility is due to an abnormality of muscle.

Several theories have been advanced to explain the development of the stress-syndrome, namely

(a) decreased adrenocortical function [62, 63]
(b) hyperirritability of muscle [64]
(c) uncoupling of oxidative phosphorylation [50, 53].

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It has also been shown that stress-susceptible animals have higher percentages of white fibres and less red fibres in their skeletal muscles than stress-resistant animals [65]. A decreased capillary density was also noted in the musculature of the stress-susceptible animals. These results suggest that higher rates of glycolysis act as a compensatory mechanism for the maintenance of the high-energy phosphate potential (phosphocreatine, ATP) of the muscle fibre. It has also been suggested [51] that the ATP content of muscle in stress-susceptible pigs may be lowered by a highly active ATPase, since pigs such as the Pietrain develop *rigor mortis* soon after slaughter, and this is associated with a rapid rate of *post-mortem* glycolysis and ATP hydrolysis. The particular ATPase which acts as the rate-limiting step has not been identified unequivocally, but sarcoplasmic reticulum ATPase has been implicated by some workers [66], and myofibrillar ATPase by others [67, 68]. The rapid production of lactate and breakdown of ATP whilst the muscle temperature is still around 37°C leads to denaturation of the sarcoplasmic and myofibrillar proteins, and the muscle becomes pale, soft and exudative as it goes into *rigor mortis* [69-72].

In bovines, hereditary muscular hypertrophy is an inherited disorder of skeletal muscle growth and development, and it appears that muscle hypertrophy is the result of a single gene pair with the phenotype of the heterozygote intermediate between the alternate homozygous conditions [73]. The phenotype of the homozygous mutant is best described as a generalized muscle hypertrophy, although the diaphragm may be considerably underdeveloped [74]. The skeletal muscles of the mutant have a more anaerobic fibre type than the normal homozygous animals [75]. It will be of interest to see the further development of these mutants in view of the existence of stress-susceptibility in the corresponding type of pig.

RELATION BETWEEN RATE OF POST-MORTEM METABOLISM AND MEAT QUALITY

The generally accepted primary criteria of meat quality are: (a) water-holding capacity, (b) tenderness and (c) colour. The practical importance of the subjects discussed in the preceding sections lies in the fact that the water-holding capacity, tenderness and colour of meat are determined by the physiological status and *ante-mortem* treatment of the animal. The biochemical basis of these quality criteria will now be outlined.

(a) *Water-holding capacity* may be defined as the capacity of the muscle proteins to bind water. It is determined by the spatial configuration of the contractile proteins in the myofibrillar network and by the ionic interactions between the ions of the sarcoplasm and the contractile proteins. Loss of sarcoplasmic ions, protein denaturation owing to heat and *rigor mortis* all result in a decrease in the water-holding capacity. It is clear that factors causing any one or more of these effects also leads to a lowering of the water-holding capacity. In animals which have been subjected to a minimum of *ante-mortem* stress, the normal pattern of development of *rigor mortis* is accompanied by a small decrease in the water-holding capacity of the muscle owing to the formation of rigor contraction bonds and the approach of the muscle pH to that of the isoelectric points of the contractile proteins. Rapid *post-mortem* glycolysis caused by stress-susceptibility or the slaughter method, however, leads to a massive decrease in the water-holding capacity of muscle owing to the simultaneous occurrence of high temperature (>35°C) and high concentrations of lactate. The muscle proteins are denatured under these conditions, leading to a large increase in the mobile water phase of the muscle which manifests itself *post-rigor* (i.e. in meat) as excessive fluid loss. This is further accentuated by loss of the sarcoplasmic ions in the fluid.

(b) *Tenderness.* Tenderness is determined to a large degree by the extent of contraction occurring during the onset of *rigor mortis*. The tenderness of meat decreases with decreasing sarcomere length. The extent of sarcomere shortening is greatest when the muscle temperature is close to 37°C, as happens during rapid *post-mortem* glycolysis, and is least at 15—20°C.

In some animals, notably bovines, extensive contraction has been observed at 2°C in pre-rigor muscle. The occurrence of contraction at temperatures near 0°C is referred to as "cold shortening". The phenomenon is of considerable importance in the meat industry since it causes increased toughness in the superficial layers of muscles of carcasses cooled immediately after slaughter [78].

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(c) *Colour.* The colour of meat is due primarily to the presence of the haemoprotein, myoglobin, in the sarcoplasmic fluid. Myoglobin exists in three forms: combined with oxygen as oxymyoglobin which has a bright, cherry-red colour; as myoglobin which is purplish in colour; and as the brown metmyoglobin, in which the iron of myoglobin exists in the ferric state. The actual colour of the meat will depend on the proportion of each compound present. The structure of meat also affects its colour. When the ultimate pH is high (>6,0) the meat has a closed structure and is dark red in colour. At lower ultimate pH values meat assumes an open structure owing to increased fibre shrinkage and the proximity of the pH to that of the isoelectric points of the contractile proteins, leading to a progressive increase in paleness.

Skeletal muscle remains metabolically active for some hours after death. During this period ATP is hydrolysed continuously by the muscle ATPase enzymes. The rate of ATP hydrolysis in the muscle cell determines the rate of *post-mortem* glycolysis. ATP is resynthesized as long as phosphocreatine and glycogen are present in adequate amounts, but the characteristic activity of the muscle cell disappears when the ATP is depleted and the muscle passes into *rigor mortis*. The rate of metabolism *post mortem* in porcine muscle is a very variable quantity which is profoundly affected by genetical, physiological and environmental factors. *Post-mortem* glycolysis is frequently rapid; lactic acid, the end product of anaerobic glycolysis, plays a major rôle in the determination of meat quality, since high levels in muscle owing to rapid glycolysis denature the sarcoplasmic and myofibrillar proteins while the muscle temperature is close to 37°C. The denatured sarcoplasmic proteins precipitate and form aggregates around the myofibrils, thereby reducing myofibrillar protein solubility. Such aggregation of protein may mask the colour of muscle owing to myoglobin, which itself is a sarcoplasmic protein. Denaturation results in an increase in the free water in muscle, which manifests itself in meat as excessive fluid loss. As indicated in the preceding section, these are the changes which are seen in porcine muscle after accelerated *post-mortem* glycolysis in the musculature and collectively referred to as the pale, soft, exudative muscle condition.

In rapidly glycolysing *post-mortem* muscle extensive shortening of the myofibrils occurs at the prevailing high temperatures in the muscle. The sarcomere length is decreased, and myosin-actin cross-links form as the ATP concentration in the muscle approaches zero. Sarcomere shortening during the onset of *rigor mortis* is one of the main determinants of meat tenderness; this aspect has been reviewed recently [76]. The length of the sarcomere is a direct measure of the extent of muscular contraction undergone by a muscle. Meat tenderness has been shown by several researchers [77-79] to depend on the contraction state of the muscle as well on the nature and amount of collagen. Additionally, such contraction during the onset of *rigor mortis* causes a further expression of muscle water from the myofibrillar interspaces, thus increasing fluid loss from the derived meat.

It is not generally appreciated that the mode of slaughter also plays a major rôle in the determination of the rate of *post-mortem* glycolysis in muscle. Carbon dioxide, electrical and captive-bolt stunning of pigs prior to exsanguination produces rapid *post-mortem* glycolysis in pig muscle and an increased incidence of pale, soft, exudative muscle [80-81]. In the case of captive-bolt stunning, neural stimuli caused by the impact of the bolt pass down the spinal column in the intact motor tracts and finally activate the muscles, leading to an accelerated rate of *post-mortem* glycolysis. The rate of *post-mortem* glycolysis is reduced by intramuscular administration of the neuromuscular blocking agent d-tubocurarine before death [82, 83]. The adverse effects of electrical stunning clearly arise from stimulation of the cortical motor centres, which causes muscular contraction, and probably also from the secretion of epinephrine by the adrenal medulla owing to stimulation of the autonomic nervous system. Carbon dioxide has well-known anaesthetic properties and its metabolic effects are alteration of acid-base equilibrium, elevation of blood lactate and decreased pH. Indeed, the anoxia associated with the high levels of carbon dioxide used in commercial-stunning procedures may well stimulate the rate of *post-mortem* glycolysis in stress-susceptible pigs.

Reference was made in the preceding section to the increased proportion of white fibres in the muscles of pigs selected for high growth rates, indicating that the greater anaerobic metabolic capacity of such muscle predisposes the animal to the development of

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the pale, soft, exudative condition. Some reports have appeared indicating that this is in fact the case[84, 85]. The literature contains many references showing that white fibres are larger than red fibres. It may be deduced, then, that selection of pigs for high growth rate and total muscle mass was associated with inadvertent selection for increased proportions of larger, anaerobic, white fibres in the muscles together with adrenocortical hypofunction. Adrenocortical hypofunction produces a decreased capacity to accommodate stress and would tend to make the muscles more dependent on glycogen metabolism, since gluconeogenesis would no longer be able to take place. Such changes in metabolism manifest themselves in stress-susceptibility, development of the pale, soft, exudative muscle condition, and probably also in malignant hyperthermia.

Present evidence, although indirect in most respects, suggests that a desirable meat producing species should be physiologically oriented to a highly aerobic muscle metabolism together with an increased adaptational capacity for a wide variety of stressors. Biochemically this means selection for an oxidative muscle fibre type together with an efficient hypothalamic-pituitary-adrenal function At present no methods are available for genetic selection of these parameters, primarily because our knowledge of the molecular basis of muscle differentiation is not understood and because of our incomplete knowledge of the complex interaction between the hypothalamus, the pituitary and adrenal glands.

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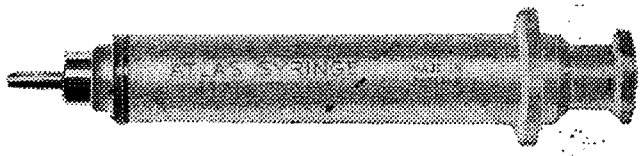

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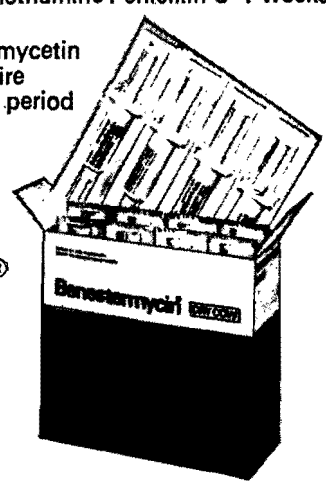

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REVIEW

OORSIG

CANINE HIP DYSPLASIA

L. I. KANN*

SUMMARY

The radiographic diagnosis of hip dysplasia is reviewed and pectineal myotomy discussed. The introduction into South Africa of a scheme to reduce the incidence of canine hip dysplasia is suggested.

INTRODUCTION

Hip dysplasia may be defined as the malpositioning of the joint surface of the femoral head relative to that of the acetabulum, leading to abnormal wear of the joint cartilage, thickening of the joint capsule and formation of periarticular osteophytes. It develops during early adulthood. Rapid growth, especially during the period three to five months of age, aggravates its progression [15]. On the other hand, confinement for several months of puppies older than thirty days decreases the chances of the development of the condition [19].

As there appears to be a genetic predisposition [8, 14], exclusion of dogs with hip dysplasia from any breeding program will be an obvious measure to reduce the incidence of the disease [25]. Surgery, however successful in the individual case, must be regarded as a palliative in the face of the problem as a whole Accurate diagnosis is the first and most important step, and here radiography plays a rôle of overriding importance. Its proper application entails strict observance of certain practical rules.

THE RADIOGRAPHIC DIAGNOSIS OF HIP DYSPLASIA

As good quality radiographs are necessary for a critical assessment to be made, it is essential that the patient be correctly positioned under general anaesthesia, and that a grid be used.

Positioning the Patient

Radiographs should be taken with the dog in two positions, in both of which the hip joints must be projected symmetrically [7, 17]. One radiograph is taken with the dog in dorsal recumbency, the hind legs being fully extended and slightly adducted so that the patella lies directly above the trochlea (Fig. 1) As little as a 2° rotation of the pelvis will produce an asymmetrical radiograph which may show an apparent subluxation of the elevated hip [10].

The second radiograph is also taken with the dog in dorsal recumbency, but now the hind legs are maximally flexed and abducted (Fig. 2). It is important that the long axis of the pelvis be parallel to the plane of the cassette, because if the pelvis is tilted forward, a fore-shortened image of the pelvis will be obtained (Fig. 3), which will increase the apparent depth of the acetabulum [16, 17]. This will be misleading when the radiograph is assessed.

Radiographic Anatomy of the Hip Joint

In order to assess the hip joints accurately it is necessary first to know and understand the normal appearance of this joint. Three components of the hip joint must be studied: the acetabulum, the femoral head, and the joint space between these two structures.

The acetabulum (Figs. 4 and 5) should be deep and describe a semicircle. The only irregularity in its contour is the acetabular fossa (a) which separates the cranial acetabular edge (b) from the caudal acetabular edge (c). The dorsal acetabular edge (d) is visible through the image of the femoral head, extending from the caudal end of the acetabulum to the point where it meets the cranial acetabular edge. This meeting point of dorsal and cranial acetabular edges is known as the "cranial effective acetabular rim" (e) and it is through this point that one of the lines is drawn to measure the femoro-acetabular angle according to Norberg's method (see below). Any exostoses that may develop at this point must be recognized, so that lines are not drawn through points which are lateral to the *true* cranial effective acetabular rim.

In the extended position the *femoral head* has a smooth rounded outline describing about two thirds of a circle. The fovea capitis (f), the area at which the teres ligament attaches, is visible as an irregularity in the otherwise even contour of the femoral head. The junction of the head and neck of the femur is smooth.

In the flexed position, the head of the femur appears as a semicircle with an even curvature throughout. The fovea capitis is not visible in this position.

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Fig. 1: Positioning of dog for pelvic radiograph in extension.

Fig. 2: Positioning of dog for pelvic radiograph in flexion.

Fig. 3: Foreshortened pelvic image produced by incorrectly tilting the pelvis forward. Note the **apparent** depth of the acetabula.

The line which appears between the femoral head and the articular surface of the acetabulum is *the joint space*. This should be regular and even, except at the area of the acetabular fossa and the fovea capitis. The femoral head and acetabulum should lie in intimate contact with each other and their surfaces should form concentric arcs.

Dysplastic changes

The changes seen radiographically in these structures in cases of hip dysplasia are a shallowness of the acetabulum and an abnormal position of the femoral head. The secondary changes seen are the development of the exostoses on the acetabulum at various points, exostoses on the femoral head and neck junction, and the formation of new articular facets in the acetabulum, i.e. bilabiation.

The acetabulum may be recognized to be shallow on simple inspection. A more precise and rigid method of estimating the shallow-

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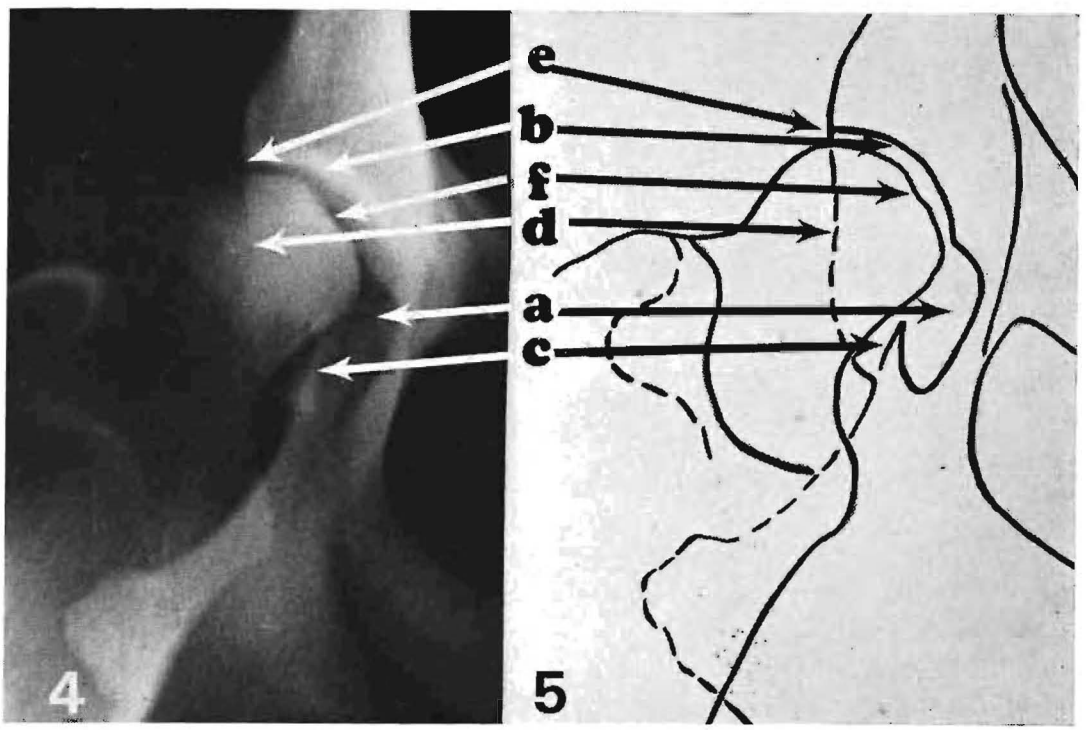
ness of the acetabulum is by means of Norberg's method (Fig. 6 and 7). For this measurement the radiograph in the FLEXED position is used [17]. A transparent plastic sheet with concentric circles engraved on it is placed over the image of the head of each femur to determine its midpoint (Fig. 6). A line is drawn between the midpoint of the two femoral heads; another line is drawn from the centre of the head of the femur through the cranial effective acetabular rim of that side (Fig. 7). The angle thus formed is measured with a protractor, an angle of less than 105° being an indication of a shallow acetabulum. This should not be accepted as the only criterion of dysplastic change. Exostoses are most commonly found at the cranial effective acetabular rim, but may also be seen along the dorsal acetabular edge, caudal acetabular edge and in the acetabular fossa. Bilabiation, or the formation of new articular facets, may be recognized.

Exostoses of *the femoral head* are visible in the radiograph in flexion, but are more easily seen as a ring formation at the junction of the femoral head and neck on the radiograph taken in the extended position. A grading system is in operation to describe the degree of displacement of the head of the femur [20]. In grade I there is a minimal deviation from normal, with minor subluxation and remodelling changes. Grade II includes those cases with marked lateral subluxation of the femoral head, extending quarter to half of the way out of the acetabulum, and with exostoses of both the femoral head and the acetabulum. Where the femoral head is laterally and dorsally displaced from half to three quarters of the way out of the acetabulum, and marked exostoses and remodelling changes are seen, grade III hip dysplasia may be diagnosed. Total lateral displacement of the femoral head, accompanied by flattening of the acetabular rim and the femoral head, are the features seen in the radiograph of the grade IV dysplastic dog.

The examination of the *joint space* is the most critical method of assessing the presence of minor displacement of the femoral head. Where the hip is subluxated, the contours of the head of the femur and the cranial acetabular edge are no longer parallel, but diverge



Figs. 4 and 5: Radiographic anatomy of the hip joint. (a) Acetabular fossa. (b) Cranial acetabular edge. (c) Caudal acetabular edge. (d) Dorsal acetabular edge. (e) Cranial effective acetabular rim. (f) Fovea capitis.

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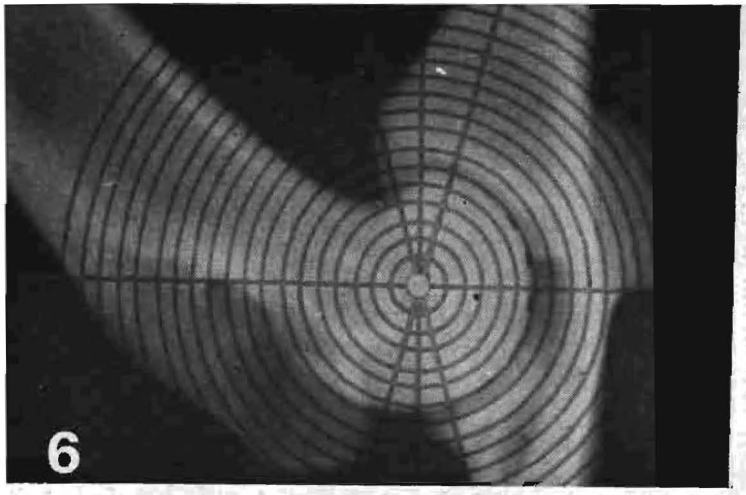

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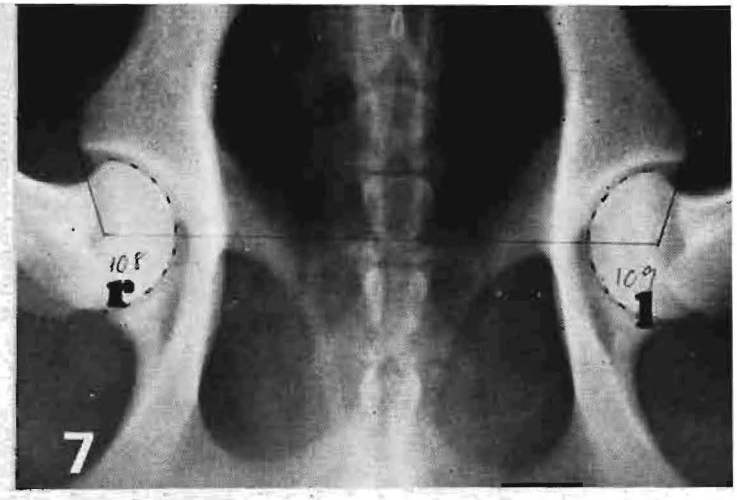

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Fig 6: Method of determining the centre of the femoral head by means of concentric circles on transparent overlay.

Fig. 7: Measurement of depth of the acetabulum by means of Norberg's method.

Fig. 8: Pelvic radiograph in extension of the right hip. Note: shallow acetabulum, exostoses at cranial effective acetabular rim, enlarged joint space, flattened femoral head and exostoses at the junction of the femoral head and neck.

Fig. 9: Pelvic radiograph in flexion of the same dog as in fig. 8. Note the appearance of the enlarged joint space, and the exostoses at the junction of the femoral head and neck (arrow).

Fig. 10: Pelvic radiograph in extension showing severe dysplasia. Note shallow acetabula, bilabiation at cranial effective acetubular rims, flattening of the cranial acetabular edges, exostoses in the acetabular fossae (cf. Fig. 8) and at caudal acetabular edges. Note also the altered joint spaces, remodelled heads of the femora and the exostoses at the junction of femoral head and neck on both sides.

Fig. 11: Radiograph in flexion of the same dog as in fig. 10.

Fig. 12: Pelvic radiograph in extension of six month old German Shepherd Dog. Note lateral displacement of femoral heads and the enlarged joint spaces. Bilabiation can be seen at the cranial effective acetabular rim on both sides. Exostoses are present at the caudal acetublar edge on the left side.

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as they are traced backwards. This change is visible in the radiographs taken in the extended and in the flexed position.

It should be appreciated that the condition of the hip joint is in a continuous state of change; even the hips of dogs not suffering from hip dysplasia deteriorate with advancing age [24]. Only 70% of dogs that might eventually have dysplastic changes on radiographic examination can be identified at one year of age, [10,11], which is the generally recommended age for the routine radiographic examination of stud dogs. At this age the dogs are still young enough to enjoy a full breeding life. Animals younger than one year of age should not be accepted for routine radiographic examination in a breeding program [2, 26], although young dogs showing clinical signs of hip dysplasia should be radiographed regardless of age.

The wedge of fulcrum technique [5] for pelvic radiography consists of placing the animal in the extended position for radiography. A round wedge is placed between the femora as close to the anus as possible. The tibiae are grasped distal to the stifles and pressure applied medialward. This technique greatly increases the joint space of the hip joint, the degree depending on a) the inherent laxity of the joint, b) the depth of anaesthesia and c) the force applied to achieve the desired position [23]. This wedge technique adds little information [18] to that obtained by conventional positioning of the dog.

THE CLINICAL DIAGNOSIS OF HIP DYSPLASIA BY PALPATION

The value of the palpation method of diagnosis in young pups [3, 4, 5, 12] is still questionable [1], as several studies cast doubt upon the supposition that laxity of the hip joint *per se* is synonymous with hip dysplasia [15, 22].

THE SURGICAL TREATMENT OF HIP DYSPLASIA

All surgical treatment of hip dysplasia must, at the best, be regarded as palliative. This consists of excision arthroplasty of the femoral head and neck, pelvic osteotomy, or more recently, pectineus muscle surgery.

Pectineal Myotomy/Tenotomy

Since 1968 attention has been drawn to pectineus muscle and its possible aetiological rôle in the development of hip dysplasia [3]. Subsequent investigations were undertaken to determine whether the pectineus muscle might be related to the pain and discomfort that lame dysplatic dogs experience [28, 29]. It has been shown that the lame dysplastic dog can be rehabilitated by sectioning the pectineus muscle or its tendon of insertion [6, 21, 23, 29]. Pectineal tenotomy or myotomy is not a cure for hip dysplasia. It is intended only to relieve pain and not to restore a normal gait, although occasionally a younger dog of five to six months of age may develop a normal gait after surgery. It cannot be predicted how long the animal will be free of pain, but Wallace, reporting on a series of cases treated by this method, achieved a success rate of 94% over a period of four and a half years [29]. In all cases of surgical treatment of hip dysplasia the owners must be informed that the dog should not be used for breeding purposes.

Giardina & MacCarthy [13] have reported that bilateral pectineal tenotomy performed on young pups classified as predysplastic (based on palpation) seemed to reverse the expected development of hip dysplasia when these animals were radiographed at one year or older. Nevertheless, it has been shown that pectineal tenotomy does not reduce the severity or alter the rate of progression of dysplastic changes, [9, 29], hence pectineus muscle surgery in the predysplastic puppy must be regarded as an unwarranted procedure.

DISCUSSION

At present the only method of reducing the incidence of hip dysplasia is by the accurate identification of dogs with dysplastic hips, by means of pelvic radiography and their exclusion from breeding programs. A long term breeding program would follow this up with progeny testing. For this purpose, dogs that are radiographically free of hip dysplasia could be divided into four classes as follows [27]:

Class 4: Dogs without any radiographic signs of hip dysplasia.

Class 3: The dog and both its parents being radiographically free of hip dysplasia.

Class 2: The dog and its parents and either its four grandparents, or six full brothers and sisters, or at least six of its offspring being radiographically free of hip dysplasia.

Class 1: The dog and its parents and its four grandparents, six full brothers and sisters and at least six of its offspring being radiographically free of hip dysplasia.

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In such a breeding program, initially all dogs to be used must be classified as at least class 4. This should be followed by mating class 4 dogs with those of class 3. The use of dogs only of class 2 and class 1 would be advocated as more of these dogs became available.

The success of such a breeding scheme depends upon uniformity in the radiographic diagnosis of hip dysplasia. In South Africa such uniformity could best be achieved by the appointment of a panel of veterinarians to whom all radiographs for evaluation for hip dysplasia would be submitted. The success of pectineal tenotomy as a palliative procedure should not be a deterrent to the initiation of such a scheme.

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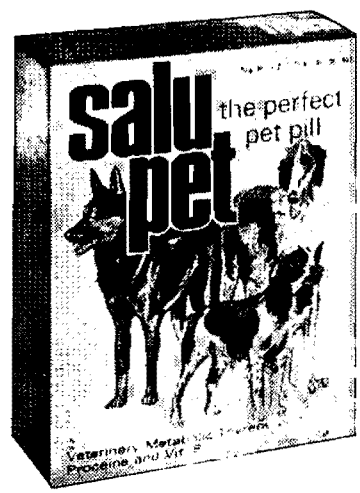

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ANATOMICAL AND HISTOLOGICAL OBSERVATIONS ON THE REPRODUCTIVE TRACT OF MARES WITH ABNORMAL OESTROUS CYCLES

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SUMMARY

An anatomical and histological study of the reproductive organs of (A) mares in deep anoestrum with inactive ovaries, (B) mares in shallow anoestrum with active, non-cycling ovaries, and (C) mares with long oestrous periods with active, non-cycling ovaries was made on 42 maiden and barren mares.

The observations may be summarized as follows:

In group A there was marked inactivity of all genital organs: the follicles were incompletely developed, less than 5 mm in diameter and more often than not undergoing atresia typical of small follicles, no *corpora lutea* were present; the uterus was toneless and difficult to palpate, its mucosa pale and dry with low cubodial epithelium, the uterine glands small and inactive; and the vagina was pale, dry and sticky, with low, non-keratinized epithelium.

In group B there was more activity of the genital organs: the follicles were larger up to 3 cm in diameter, with both small and large follicular types of atresia but without *corpora lutea;* the uterus was toneless and difficult to palpate, its mucosa pale but glistening, with low, columnar epithelium, and the number and size of the uterine glands were greater; the vagina was pale, but less sticky, with low, non-keratinized epithelium.

In group C activity was highest, but still less than in oestrum: the follicles were larger, but had failed to ovulate; both types of atresia were seen but no *corpora lutea;* the uterus was easy to palpate, its mucosa more moist, with higher epithelium and the number and diameter of the glands were increased; the vagina was moist and glistening, with lightly keratinized epithelium and well-developed epidermal papillae.

INTRODUCTION

For economic reasons breeders prefer to get their mares in foal as early as possible in the breeding season. The main problem that faces breeders and veterinarian is the abnormal oestrous cycle so commonly encountered in this period, referred to as the "early part of the breeding season" [7, 16, 17].

It is recognized and well documented that in this period heat cycles are irregular and characterized by incomplete ovarian function, as for instance is found in mares in deep anoestrum with completely inactive ovaries, in mares in shallow anoestrum with active, but non-cycling, ovaries or in mares with abnormally long oestrous periods and active, but non-cycling, ovaries [1, 2, 4, 6, 7, 8, 13, 14, 17].

The incomplete ovarian function, whereby the growth of follicles does not terminate in ovulation, is the main cause of low conception rates early in the breeding season. The clinical picture of these abnormal cycles has been well described [3, 5, 6, 7, 12], but little information on the morphology of the sexual tract and endocrine status during these abnormal cycles could be found. The results obtained in treating such aberrations with hormones can be blamed on the empiricism underlying the treatment [4]. An intensive study of the anatomy and histology of the reproductive organs during these cycles is a prerequisite to the understanding of the processes involved and a first step towards solving this important problem in horse breeding.

MATERIAL AND METHODS

The data to be presented were gathered during the months of July, August, September and October from 42 maiden and barren mares of the light farm type. Twelve of these mares (Group A) were in deep anoestrum with inactive ovaries, sixteen (Group B) in shallow anoestrum with active, but non-cycling, ovaries, and fourteen mares (Group C) had abnormally long heat periods with active, but non-cycling, ovaries.

From the middle of July all the mares were teased daily by an active stallion and the results were recorded. Ovarian and ute-

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rine changes were observed by rectal palpations daily in mares with active ovaries or every second to third day in mares in deep anoestrum with inactive ovaries. Five mares in Group A, nine in Group B and one in Group C were slaughtered. The genital tract of each mare was removed immediately and the ovaries dissected free, measured and weighed. The number and size of the largest follicles were recorded and the ovaries were examined for *corpora lutea*. The uterus was placed on a flat surface and in this position measurements of the width of the horns were taken ± 2,5 cm from the bifurcation. The width of the uterine body was measured midway between the cervix and the bifurcation. The uterus, cervix and vagina were then opened, the thickness of the horns was measured and the microscopic appearance of the mucous membrane of the entire tract was recorded.

Tissue samples were taken from each ovary, from the wall of both uterine horns ±2,5 cm from the bifurcation and from the wall of the vagina. These tissue samples were fixed in Zenkers fluid, washed, dehydrated, embedded in paraffin wax, sectioned at 5-10 μm and stained with haematoxylin-eosin.

A detailed histological study of these organs was made. The height of the uterine and glandular epithelium, as well as the diameter of the uterine glands and the width of the glandular area as seen in cross-section, was measured by means of an ocular micrometer. The height of the vaginal epithelium was measured between, as well as on, the epithelial papillae to obtain an average thickness. Each named structure was measured in fifty different places to obtain its average thickness.

RESULTS*

The Inactive Ovaries of Mares in Deep Anoestrum (Group A)

The average size of the ovaries of eight of the mares in deep anoestrum estimated by rectal examination over a period of at least 2 months was found to be 2,4×1,6×1,6 cm: it varied between 2.5×2×2 and 2×1×1 cm.

The average actually measured size of the inactive ovaries of the five mares slaughtered in anoestrum was found to be 2,7×1,9×1,9 cm for the left ovary and 2,4 × 1,8 × 1,7 cm for the right one. Maximum and minimum measurements were 2,9 × 2,0 × 2,0 and 2,0 × 1,5 × 1,5 cm respectively. The average combined mass of left and right ovaries was 35 g, with a range of 30 to 38 g.

The quiescent ovaries were small, more or less bean-shaped, firm, either with a smooth surface or containing small, firm nodules of stromal tissue (Plate 1, Fig. 2). Histologically the cortex of the ovary consisted mainly of connective tissue stroma and blood vessels, the stroma being built up of collagen fibres with exceptionally large numbers of fibroblasts packed densely together (Plate 1, Fig. 1). Very few elastic fibres were present, except around the larger blood vessels. Microscopically small, primary follicles were arranged in rows tangential to the ovulation fossa. Because of the density of the fibroblasts it was difficult to see the primary follicles and this may have given the impression that very few primary follicles were present. (Plate 1, Fig. 1).

Developing follicles were scarce and always less than 5mm in size. Most of the larger ones of these follicles were undergoing follicular atresia: the active proliferation of the fibroblasts of the thecal stroma surrounding these atretic follicles formed the firm nodules of stromal tissue felt on rectal palpation of the ovaries. (A detailed description of follicular atresia is given on page 144). No *corpora lutea* or active luteal tissue could be found.

The Active, Non-cycling Ovaries of Mares in Anoestrum (Group B).

The average estimated size of the active, non-cycling ovaries of eleven of the mares in anoestrum over a period of at least 2 months was 3,5 × 2,9 × 2,6 cm with a range of 3,0 × 2,0 × 2,0 to 5,0 × 4,5 × 4,0 cm. The average measured size of the ovaries of nine of these mares, slaughtered in anoestrum, was found to be 4,1 × 3,2 × 2,6 cm for the left ovary and 3,4 × 2,5 × 2,3 cm for the right one. Maximum and minimum measurements were 5,0 × 4,5 × 4,0 and 3,0 × 2,0 × 2,0 cm respectively. The average combined mass of both the left and right ovaries was 75,6 g, with a minimum of 44 g and a maximum of 115 g. The marked difference in ovarian size and mass between the inactive ovaries of mares in deep anoestrum and the active, but non-cycling ovaries of mares in shallow anoestrum is due mainly to the number and size of the follicles present.

The ovaries felt knobbly and usually contained several developing and atretic follicles up to 3 cm in diameter. Consecutive rectal palpations revealed no significant change in the size of the ovaries because follicular atresia and growth of young follicles balance one another. None of the follicles reached the stage of maturity and ovulation.

*Tabulated details regarding the various measurements may be had from the senior author on request.

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Plate I

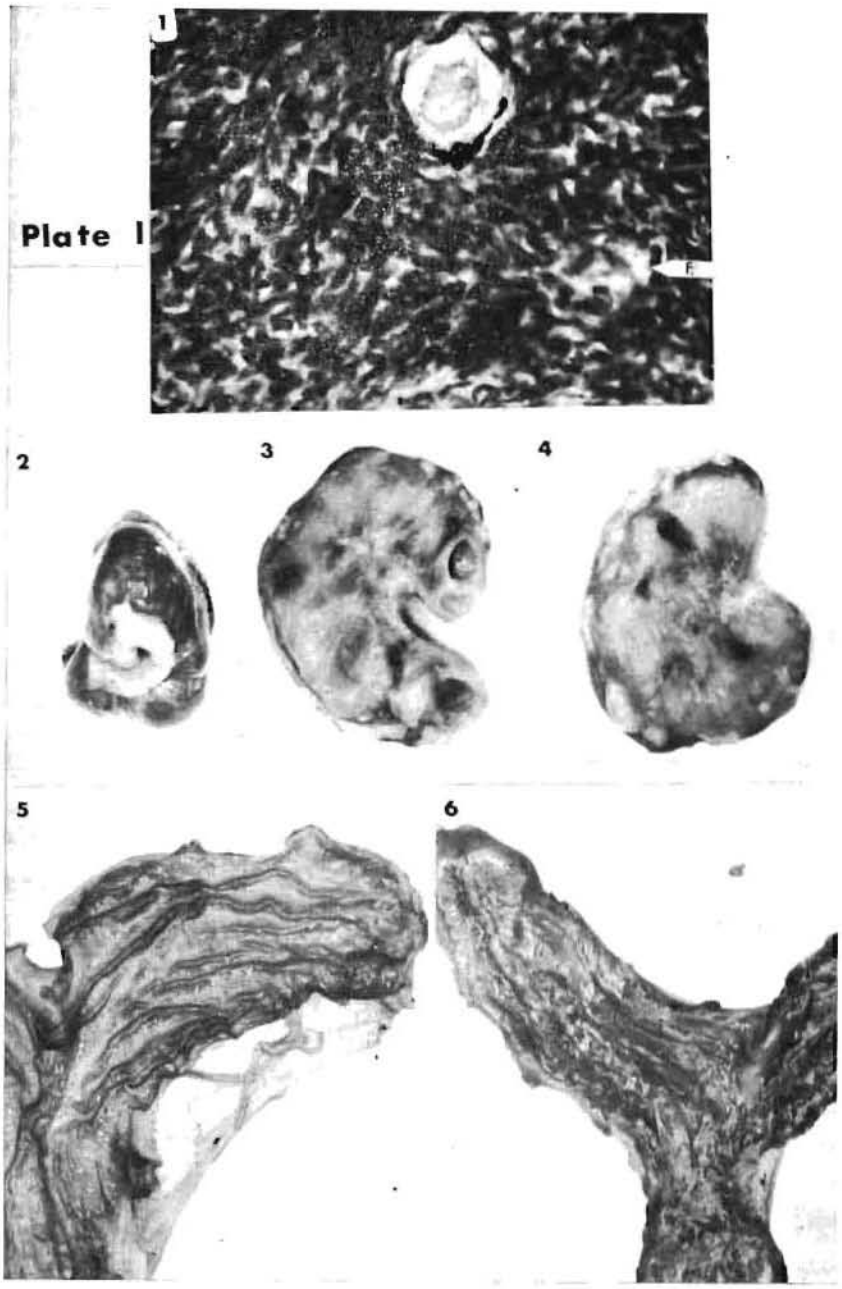

Fig. 1: (×512) Section through the inactive ovary of a mare in deep anoestrum. Note the primary follicle 30,6 μm in diameter. The nucleus and nucleolus of the oocyte is distinct. Most of the primary follicles (F) are concealed by the densely packed fibroblasts of the stromal tissue.

Fig. 2: The inactive ovary of a mare in deep anoestrum. Size: 2,3 × 1,8 × 1,6 cm. Note the absence of visible follicles.

Fig. 3: The bisected active non-cycling ovary of a mare in anoestrum. Size: 3,8 × 2,5 × 2,0 cm. Several growing and atretic follicles are visible.

Fig. 4: The bisected active non-cycling ovary of a mare with an abnormal long oestrous period. Size: 3,8 × 2,5 × 2,2 cm. Several growing and atretic follicles are visible.

Fig. 5: The opened uterus of a mare in deep anoestrum. Only a few, thin, longitudinally arranged mucosal folds are noticeable.

Fig. 6: The opened uterus of a mare with a long heat period. The longitudinal folds of the mucosa are flatter and more voluminous.

This clinical finding by regular rectal palpation of the ovaries was confirmed at necropsy: no *corpora lutea* were present in the ovaries of the slaughtered mares.

On examination of the ovaries of mares slaughtered in shallow anoestrum, numerous primary as well as several small, growing or atretic secondary follicles could be seen (Plate 1, Fig. 3). The fibroblasts of the stromal tissue, although still numerous, were not so densely packed as in the stroma of the inactive ovaries of the mares in Group A. The

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atretic changes in the small follicles of less than 5 mm in diameter were of the same type as observed in the inactive ovaries.

The large number of growing and atretic follicles between 0,5 and 2,5 cm in diameter produced a knobbly appearance on the surface of the ovary, the surface feeling like a small bunch of grapes.

The atretic changes in the walls of the larger follicles were different, being characterized by the development of a band of hyaline tissue between the theca interna and stratum granulosum. They are described in detail in a later section.

The Active Non-cycling Ovaries of Mares with Long Oestrous Periods (Group C)

The average estimated size of the non-cycling ovaries of thirteen of the mares on heat for periods ranging from 28 to 63 days was 4,0 × 3,0 × 2,5 cm, varying between 2,5 × 2,0 × 20 and 5,0 × 4,0 × 4,0 cm. The measured size of the ovaries of the one mare slaughtered while on heat for 30 days was found to be 3,5 × 2,5 × 2,2 cm for the left ovary and 3,8 × 2,5 × 2,0 cm for the right one. Their combined mass was 44,4 g.

In size, as well as in morphology, the ovaries were more or less the same as those of mares in anoestrum with active, non-cycling ovaries (Group B). On rectal palpation the ovaries felt knobbly with several developing and atretic follicles up to 2,5 cm in diameter (Plate 1, Fig. 4). None of these follicles reached the stage of maturity or ovulation during the period of observation. By contrast, most of these heat periods ended in ovulation later in the breeding season.

The histological picture of these ovaries was the same as those of the active, non-cycling ovaries of mares in shallow anoestrum and no active luteal tissue could be identified. Both types of follicular atresia were noted in the ovaries of the slaughtered mare.

ATRESIA OF FOLLICLES

The wall of the growing follicle of the mare consists of several layers of polyhedral granulosa cells, the stratum graulosum containing actively dividing, round, vesicular nuclei surrounded by a moderate amount of cytoplasm. A single basal layer of tall, cuboidal cells is arranged on the basement membrane (Plate 2, Fig. 1, 5 and 9). Differentiation of the theca interna from the stroma cells of the theca externa only takes place in the later stages of follicular development. On plate 2, fig. 5 the first stages in the differentiation of the stromal thecal cells into the theca interna cells with their large, round, vesicular nuclei is noticeable. On plate 2, fig. 9, a well-developed layer of theca interna cells is present.

Atresia is a degenerative process in which the oocyte is affected, as well as the follicular wall [11]. Atresia may begin at any stage of the development of the follicle, even in apparently mature ones. Two main types of atresia are observed in the ovaries of mares. The first type is found in the small follicles, less than 5 mm in diameter, where the theca interna cells have not hypertrophied and are not distinguishable from the theca externa cells (Plate 2, Fig. 1). The second type of atresia is found in medium-sized and large follicles (over 5 mm in diameter), where the theca interna has differentiated into a layer of hypertrophied theca interna cells easily distinguishable from the smaller fibroblasts of the theca externa (Plate 2, Fig. 9).

Atresia of Small Follicles (less than 5 mm in diameter).

The first sign of atresia is the absence of mitotic divisions in the granulosa cells. The nuclei then lose their vesicular appearance, start shrinking and become pyknotic. The cytoplasm, especially of the basal cells, shrinks, and the cells lose contact with the basement membrane as well as their regular arrangement (Plate 2, Figs. 2 and 6). In the next stage of degeneration the upper layers of the stratum granulosum slough off into the antrum of the follicle and float in the follicular fluid as large, round, pyknotic, atretic bodies (Plate 2, Fig. 7). The fibroblasts of the undifferentiated theca layers surrounding the follicle proliferate actively and grow inwards between the remaining granulosa cells, thus ultimately obliterating the antrum to form a nodule of scar tissue (Plate 2, Figs. 3, 4, 7 and 8).

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Atresia of Medium and Large Follicles

The walls of the normally growing, medium and large follicles are clearly divided into stratum granulosum, theca interna and theca externa (Plate 2, Fig. 9).

The first sign of atresia in these follicles is the appearance of lipoid droplets in the granulosa cells, pyknosis of their nuclei, and the subsequent desquamation of the granulosa cells into the follicular fluid. The more central cells are the first to be desquamated, eventually followed by the basal cells. At the same time the basement membrane between the theca interna and the granulosa cells hypertrophies and progressively thickens towards the periphery, forming a distinct hyaline membrane (Plate 2, Fig. 10 H). Some theca interna cells are enclosed in it, but others, accompanied by capillaries, penetrate it and form a layer of actively absorbing and phagocytic cells on its distal surface (Plate 2, Fig. 10b). This layer seems responsible for organizing the follicular contents. Contraction of the hypertrophied basement membrane, a phenomenon characteristic for ageing hyaline tissue, causes collapse of the follicle and apparently helps in cutting off the blood supply from the inner, phagocytic layer as soon as its rôle is fulfilled. It therefore also regresses. Eventually the antrum is obliterated and the hyaline membrane lies richly scalloped as scar tissue, forming a *corpus fibrosum atreticum* (Plate 2, Fig. 11). This type of atresia has also been described by Kampmeier [11], but he did not determine the origin and function of the phagocytic cells.

THE UTERUS OF NON-CYCLING MARES

The Uterus of Mares in Deep Anoestrum with Inactive Ovaries (Group A)

The average width of the uterine body and of the horns, and the average thickness of the walls of the horns of the four mares slaughtered in deep anoestrum were 5,4; 3,8 and 0,20 cm respectively.

The uterus was atrophic, its walls were relatively thin and toneless. This made its identification and palpation *per rectum* difficult. The opened uterus had a pale, dry mucosa which was tenacious to the touch. Only a few thin, longitudinally arranged mucosal folds were noticeable (Plate 1, Fig. 5) The colour of the endometrium covering the folds was dark to brownish yellow, while between the folds the endometrium had a light straw colour.

The microscopic measurements of the endometrium and glandular epithelium as well as the diameter of the largest uterine glands, the thickness of the glandular layer and the number of glands per 19 mm^2 are given in table 1 in the column headed "Group A". The over-all impression gained by microscopic examination was one of cytological inactivity. The epithelial cells of the endometrium were small and cuboidal with scant cytoplasm. The nuclei of these cells were relatively small and stained lightly (Plate 3, Figs. 1 and 4). The cells of the glandular epithelium were also small; their cytoplasm was scanty and their nuclei stained darkly owing to condensation of the nuclear chromatin, as is typical of inactive gland cells. The glands were relatively fewer, smaller and their diameter narrower than those in Groups B and C (Plate 3, cf. Figs. 4, 5 and 6).

The Uterus of Mares in Anoestrum with Active, Non-cycling Ovaries (Group B)

The average width of the uterine body and of the horns of four mares slaughtered in shallow anoestrum was found to be 7,5 and 6,0 cm respectively, whilst the thickness of the uterine wall was 0,30 cm.

In general, the uterus was not as atrophic as that of a mare in deep anoestrum. The body and horns were relatively wide as a result of the lack of tone in the collapsed walls. The walls were relatively thin, and the flabby, toneless horn walls could be moved against each other between thumb and forefinger when palpated rectally. It required experience to identify the uterus on rectal palpation at this stage, but the firmly closed cervix was easily identifiable and $\pm$2,5 cm in diameter and $\pm$5 cm long. On opening the uterus a pale, straw-coloured but glistening mucous membrane was revealed. The longitudinal folds were somewhat thicker than those of mares of the previous group. The mucous membrane over the longitudinal folds was brownish yellow in colour; between these folds it was thrown into smaller secondary folds (Plate 3, Fig. 2).

The microscopic measurements of the endometrial and glandular epithelium, as well as the diameter of the uterine glands, the thickness of the glandular zone and the number of glands per 19 mm^2 for mares in anoestrum but with active, non-cycling ovaries, are given in table 1 in the column headed "Group B".

The surface epithelial layer was considerably higher than in the previous group. The epithelial cells, cuboidal in Group A, were low columnar in Group B but still contained a relatively small amount of cytoplasm in

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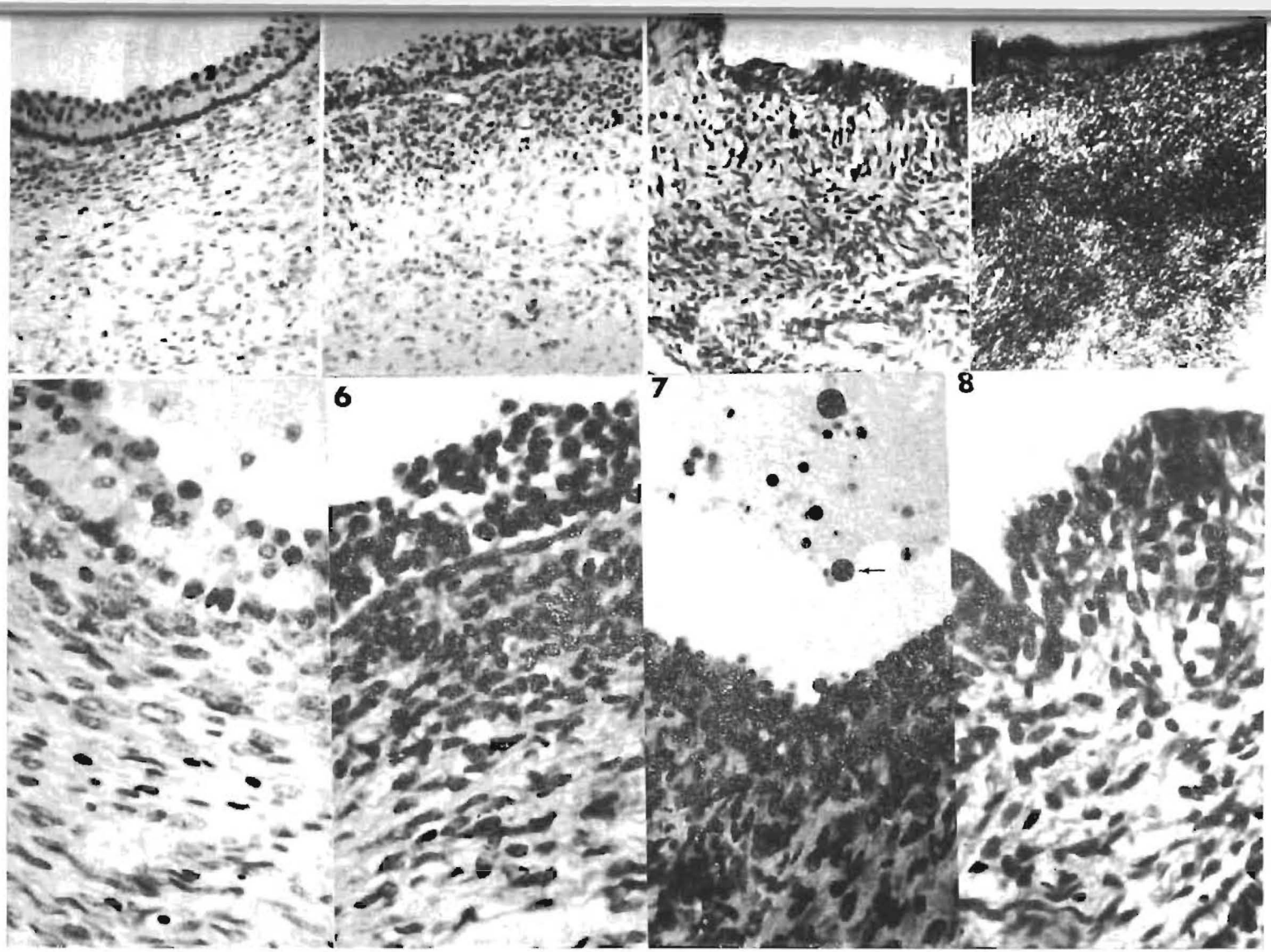

Fig. 1: (×80) Section of the wall of a small normal growing follicle. Note the well-organized stratum granulosum with its basal layer of tall cuboidal cells with proximally arranged nuclei. Differentiation between the theca interna and theca externa has not yet commenced.
Fig. 2: (×80) Section of the wall of a small follicle in the first stages of atresia. Note the disorganization of the stratum granulosum and desquamation of its distal cells. The basal layer of cells are no longer cuboidal, the nuclei are no longer arranged in a row.
Fig. 3: (×80) Section of the wall of a small follicle in a more advanced stage of atresia. Most of the granulosa cells have sloughed off into the antrum. The fibroblasts of the undifferentiated theca layers actively proliferating and invading the remaining stratum granulo

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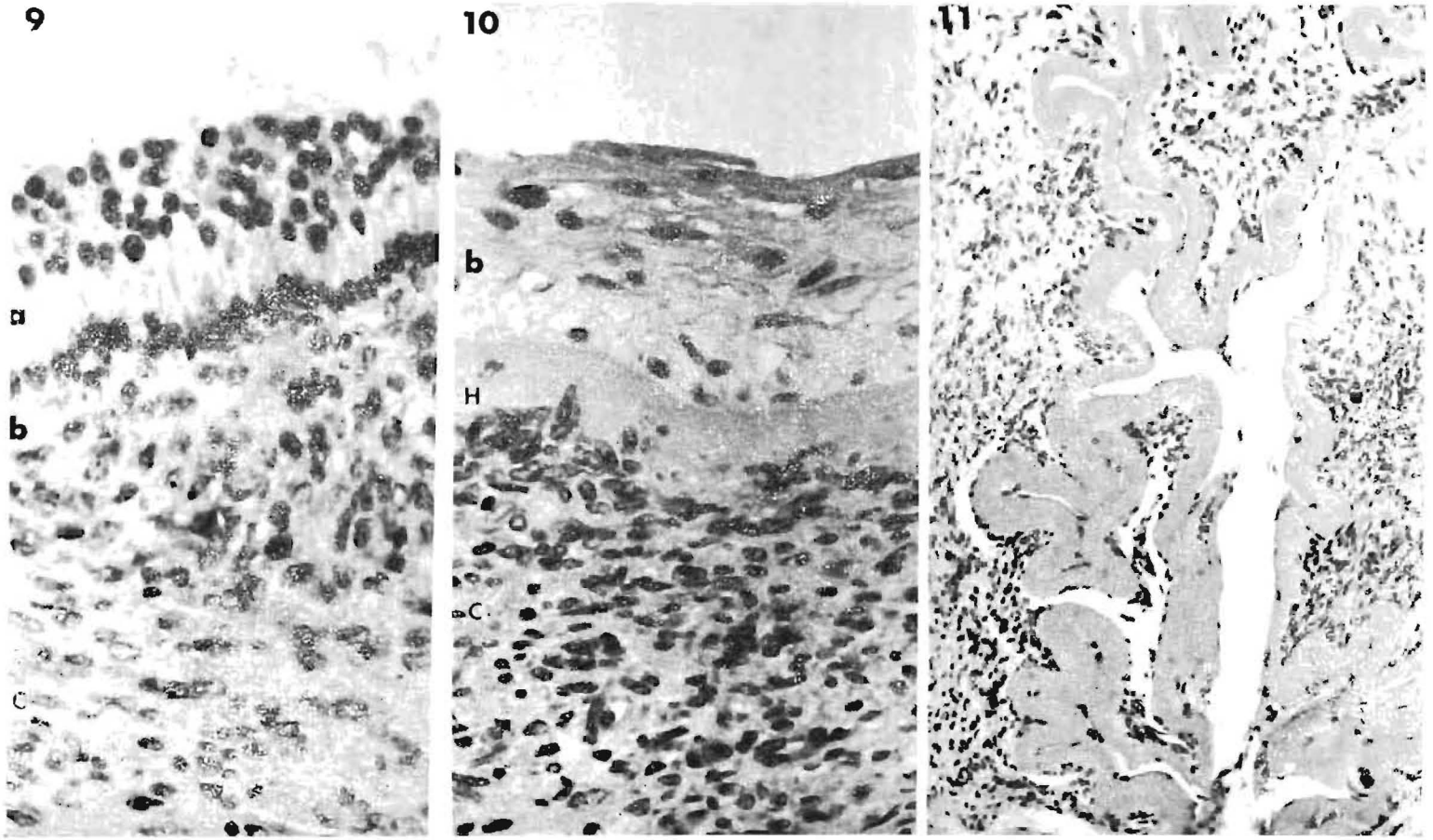
Fig. 4: (×80) Section of the wall of a small follicle at an even further stage of atresia. The fibroblastic invasion of the follicular wall is more advanced and ultimately will obliterate the antrum.
Fig. 5: (×512) A section of the wall of a normal small follicle. The stratum granulosum consists of a few layers of polyhedral cells with actively dividing, round, vesicular nuclei surrounded by a fair amount of cytoplasm. The basal layer consists of tall cuboidal cells with their nuclei arranged in a row close to the basement membrane. Note that just under these cells a few stromal thecal cells have begun differentiating into theca interna cells with large vesicular nuclei.
Fig. 6: (×512) A higher magnification of Fig 2 to show in the stratum granulosum the disorganized situation of the cells, the pyknotic nuclei, and the basal layer of cells separating from the basement membrane.
Fig. 7: (×512) Sloughing of the granulosa cells to form the pyknotic atretic bodies (arrow) floating in the follicular fluid.
Fig. 8: (×512) A higher magnification of Fig. 3 to show the active proliferation of the thecal stromal fibroblasts and invasion of the remaining stratum granulosum.
Fig. 9: (×512) A section of the wall of a medium-sized, normally growing follicle. Note the well-differentiated stratum granulosum (a), theca interna (b), and theca externa (c).
Fig. 10: (×512) A section of the wall of a medium-sized follicle undergoing atresia. Note that the stratum granulosum cells have sloughed off completely and have been replaced by a layer of phagocytic cells which have penetrated through from the theca interna. A hyaline band (H) with theca interna cells in various degrees of penetration has formed on the distal aspect of the theca interna (below H), i.e. between it and the desquamated stratum granulosum.
Fig. 11: (×512) A section of the wall of a medium-sized follicle in the late stage of atresia. The phagocytic layer distal to the hyaline band has regressed while the hyaline band itself has contracted causing collapse of the follicle and partial obliteration of its antrum.



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comparison with the epithelial cells of the endometrium of the mare in Group C (Plate 3, Figs. 5 and 6). The greater height of the surface epithelial layer of the uterine mucosa of mares in Group B was due to the increase in size of the cell nuclei. The nuclei were large, oval and vesicular and were located proximally.

The cells of the glandular epithelium were about the same size as the surface epithelial cells but the nuclei were smaller and cytoplasm more voluminous. There was also a distinct difference in the size and number of the uterine glands between mares of Groups A and B, the glands being larger and more numerous in the latter. The glandular zone was thicker, measuring 0,50 mm as against 0,18 mm (Table 1; Plate 3, Figs. 4 and 5).

The Uterus of a Mare in Extended Oestrus, with Active but Non-cycling, Ovaries. (Group C).

The width of the uterine body and horns and the thickness of the horn walls of a mare slaughtered with a long oestrous period and with active, but non-cycling, ovaries (Group C), were found to be 6,5; 5,0 and 0,5 cm respectively.

The width of the uterine body and horns measured about 1 cm less than those of mares in Group B, possibly due to some increase in uterine tone. The thickness of the uterine walls was about twice the size measured in Group B and about three times the size in Group A (Table 1).

The uteri of mares in Group C were easily indentifiable rectally. The uterine horns were flaccid and felt like a fold of velvet material; their walls could also be moved against each other between thumb and forefinger. The cervix was more relaxed and not so easily identifiable as in Group A and B.

The opened uterus had a moist glistening mucosa, which was bluish red in colour. Its longitudinal folds were flatter but more voluminous than in the uteri of the mares of the previous two groups. The secondary folds were fewer per area owing to the fact that the individual folds were wider (Plate 1; Fig 6).

The microscopic measurement of the endometrial and glandular epithelium, as well as the thickness of the glandular zone, the diameter of the glands and the number of glands per 19 mm^2, are given in table 1 under the column heading "Group C". The surface epithelial layer was considerably higher than in the previous group. The epithelial cells were tall columnar with a large amount of cytoplasm. The large, vesicular, oval nuclei lay perpendicularly to the basement membrane at the base of the cells and appeared more crowded (Plate 3, Fig. 6).

The glandular epithelial cells were smaller than the endometrial cells but somewhat larger than the glandular cells of Group B. In Group C, compared with Group B, the diameter of the uterine glands was only about 10 μm larger but the glandular zone was much wider; there were many more glands per area and glands themselves were more coiled (Plate 3, Figs. 3 and 6).

THE VAGINA OF NON-CYCLING MARES

The mucous membrane of the vagina of mares in deep anoestrum (Group A) was very pale, dry, and tenacious to the touch, and the walls stuck together. The vaginal mucosa of Group B was much the same, except that the walls did not stick together so easily. In contrast to these two groups, the vaginal mucosae of the mares in Group C were moist, glistening and pale pink in colour owing to an increase in the vascularity of the mucous membrane.

In table 1 the thickness of the vaginal epithelium of mares in Group A, B and C is given.

The mucous membrane of the vagina proper has a layer of loose connective tissue covered by a stratified squamous epithelium (Plate 3, Figs. 7, 8, and 9). The epithelia of

Table 1: THE AVERAGE MICROSCOPIC MEASUREMENTS OF THE DIFFERENT PARTS OF THE ENDOMETRIUM AND VAGINA OF SLAUGHTERED MARES IN GROUPS A, B AND C

	Group A	Group B	Group C
Height of endometrial epithelium in μm	6,5	10,2	20,4
Height of the glandular epithelium in μm	5,1	10,2	12,8
Thickness of the glandular zone in mm	0,18	0,50	0,90
Diameter of largest uterine glands in μm	32,0	52,0	65,0
Number of uterine glands per 19 mm^2	15	25	38
Thickness of the vaginal epithelium in μm	32,0	39,0	65,0

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Groups A and B were similar in thickness and consisted of four to five layers of epithelial cells. The thickness of the epithelium did not vary to any extent. The boundary between the epithelial layer and the underlying stroma was well defined in Groups A and B.

A significant difference between the epithelial layers of these two groups and Group C was noticed. In Group C the boundary was not so clear, and numerous epithelial papillae jutted into the underlying stroma (Plate 3, Fig. 9). The height of these papillae was rather variable, with a maximum height of 95 μm, to give the layer an average thickness of 65 μm. The average thickness of the epithelial layer between the papillae was the same as in Group B.

The nuclei of the epithelial cells of Group A were somewhat smaller and more basophillic than those of Group B and even more so than those of Group C. The most striking difference between Groups A, B and C was seen in the germinal layer of the epithelium. In Groups A and B the nuclei were round, but they were oval in C and the nuclei in this part were much more crowded, their long axes being parallel with each other and perpendicular to the basement membrane. Mitotic figures were frequently seen in this layer in Group C. A distinct layer of more flattened cornified cells were observed on the surface of the epithelial layer only in Group C.

Leukocytes were present in the stroma of all the three groups, but were most numerous in the stroma, as well as in the epithelial layers, in Group C. Vacuolar degeneration of the epithelial cells to form PAS-positive 'pearls' as peculiar inclusion in the stratified epithelium was found in Group B (Plate 3, Fig. 8).

DISCUSSION AND CONCLUSIONS

The mares in deep anoestrum were all maiden mares in poor condition. The over-all macroscopic and microscopic picture of the physiological status of the genital tract and ovaries of mares in deep anoestrum was one of inactivity. The uterus was small with a very thin, toneless wall. The various histological structures of the endometrium were relatively small. The ovaries were small and firm with either a smooth surface or containing firm nodules of stromal tissue. By clinical, macro- and microscopic examination little follicular growth was detected. One would expect, therefore, minimal follicle stimulating hormone (FSH) to reach the ovaries, because either none is produced in, or none is released by, the adenohypophysis. As hormonal treatment was found to be of little value in these mares[4], the organs themselves might have been refractory at this time. In the case of mares in shallow anoestrum, the ovaries were active, in so far as follicles grew to a certain stage and then underwent atresia; the presence of several developing as well as atretic follicles supports this interpretation. The uterus, although still toneless, was not atrophied as in mares in deep anoestrum. The uterus most closely resembling the uteri of mares with active, but non-cycling, ovaries is that of a normal cycling mare in the late luteal phase as described by Hammond & Wodzicki[9] and Andrew & McKenzie[1]. The surface epithelial layer, however, was thinner (10,2 μm) than that described by Andrew & McKenzie (20,0 μm)[1]. The fact that follicles were growing all the time but never reached maturity implied that FSH was being secreted continually in small quantities from the anterior hypophysis. The secretion of oestrogens caused some cellular activity in the uterus, but their level probably was not high enough to bring the mare on heat and to cause cornification of the surface layer of the vaginal epithelium.

Oestrous periods as long as 63 days were recorded early in the breeding season. These periods may even be as long as 80 days[6]. The intensity of heat is not always an indication of follicular development. So, for instance, mares intensely on heat for long periods might have relatively small ovaries with follicles less than 1 cm in diameter. There was little difference in the degree of activity, measured by follicular growth, between the ovaries of mares in shallow anoestrum and mares with long oestrous periods. On the other hand, there was a marked difference in the morphology of the genital tract between Group B and C. The surface epithelial layers of the endometrium and vagina of the latter group were about the same height and thickness as described by Hammond *et al*[9] and by Andrew & McKenzie[1]. The uterine glands were also more numerous and the glandular zone was more extensive: it measured 0,90 mm, about the same thickness (1,0 mm) as described by Hammond *et al*[9] for mares on heat. The cause of incomplete follicular growth and non-ovulation, as in Group B, apparently resulted from hypophysial dysfunction as described previously. In neither group were any *corpora lutea* found.

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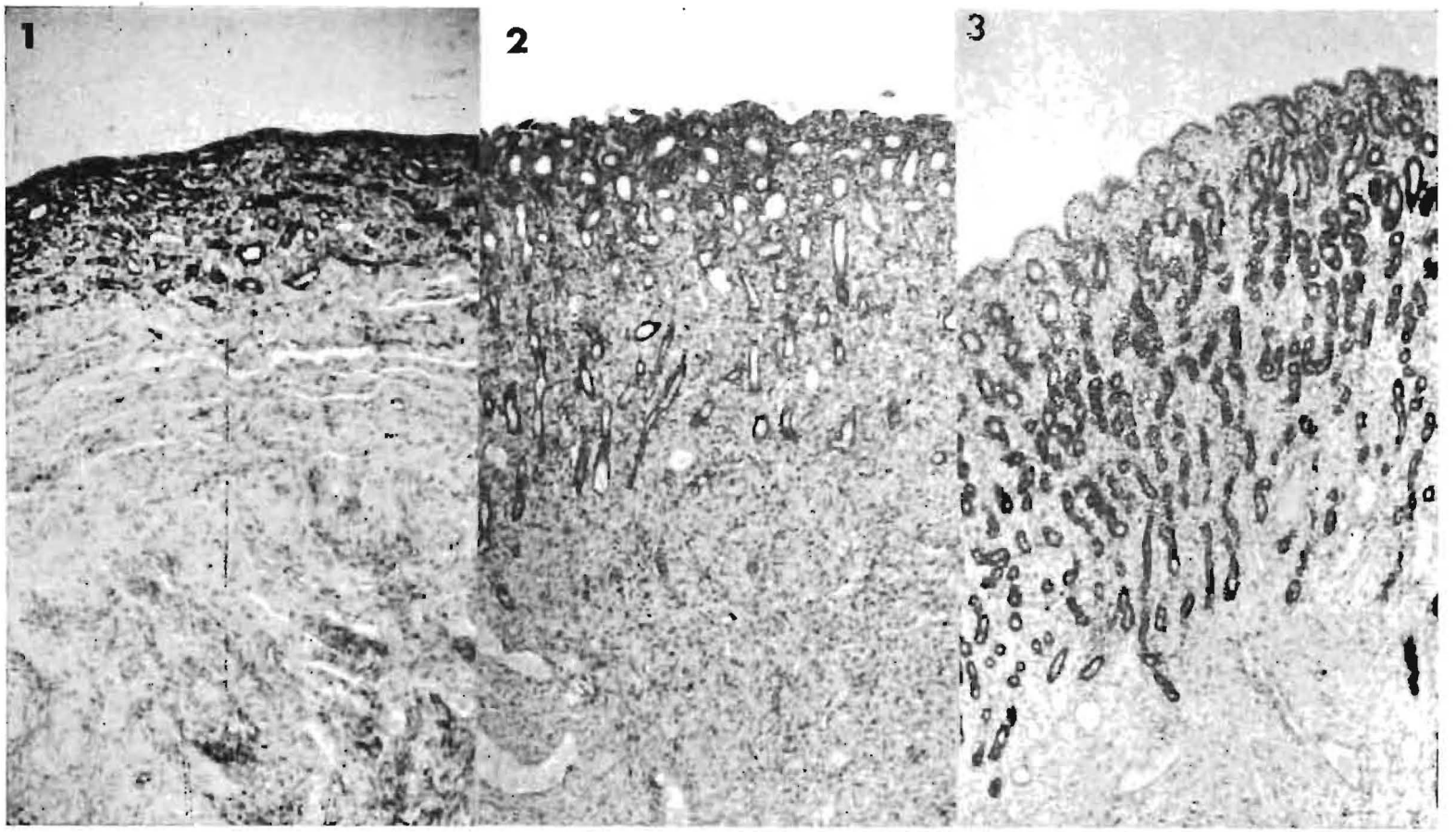

Fig. 1: (×80) A section through the wall of the uterus of a mare in deep anoestrum. Note the smooth endometrial surface and the narrow zone of glandular tissue.
Fig. 2: (×80) A section through the wall of the uterus of a mare in shallow anoestrum. Note that the surface of the endometrium is thrown into small secondary folds. Compared with Fig. 1, the glandular zone is about twice as wide, there are more glands present and the diameter of the glands is greater.
Fig. 3: (×80) A section through the wall of the uterus of a mare during an abnormally long oestrous period. Compared with Fig. 2, the secondary folds on the endometrial surface are larger, the glandular zone is about twice as wide, there are more glands per unit area and they are more coiled.
Fig. 4: (×512) A higher magnification of Fig. 1. The epithelial cells are cuboidal with a small amount of cytoplasm and small nuclei. The epithelial cells of the glands are small, condensed and stain darkly.
Fig. 5: (×512) A higher magnification of Fig. 2. Compared with Fig. 4, the surface epithelial cells are much higher, being low columnar. The nuclei are large, oval and lie vertically to the basement membrane. The diameter of the glands is greater and the epithelial cells are about as large as the surface epithelial cells although their nuclei are smaller.
Fig. 6: (×512) A higher magnification of Fig. 3. Compared with Fig. 5, the surface epithelial cell layer is higher, now being tall columnar with a large amount of cytoplasm. The large oval vesicular nuclei are more densely packed and lie vertically to the basement membrane. The glandular epithelial cells are smaller than the surface cells, but somewhat larger than the glandular cells of Fig. 5.

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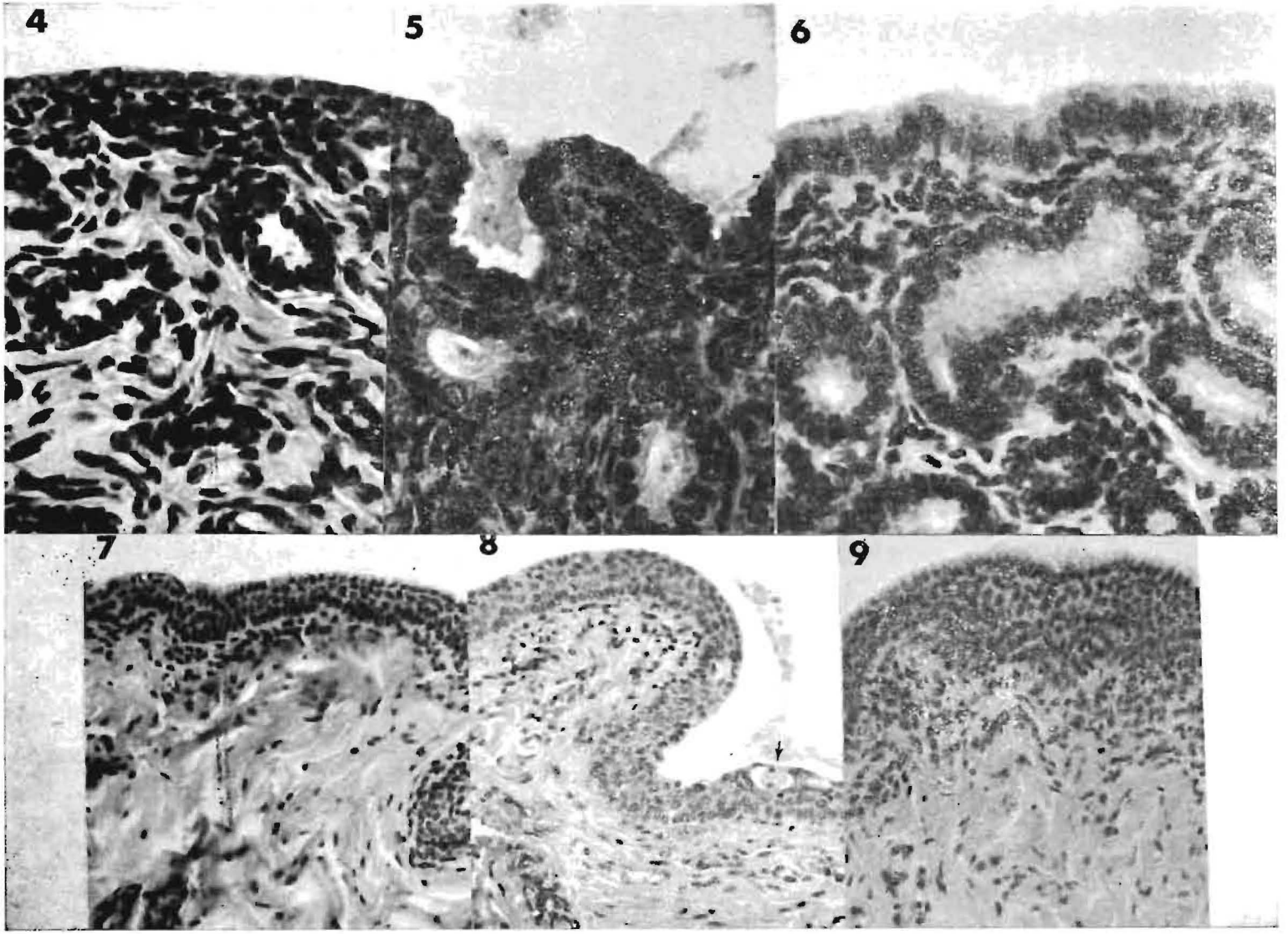
Fig. 7: (×205) A cross-section of the wall of the vagina proper of a mare in deep anoestrum. The epithelium consists of about five layers of polyhedral cells and its thickness is more or less uniform.
Fig. 8: (×205) A cross-section of the wall of the vagina proper of a mare in shallow anoestrum. There is very little difference between this epithelium and that in Fig. 7. Note the presence of a 'pearl' in the epithelium (arrow).
Fig. 9: (×205) A cross-section of the wall of the vagina of a mare during an abnormally long oestrous period. Note that the nuclei of the germinal layer of the epithelium are crowded, oval in shape with their long axes perpendicular to the basement membrane. The thickness of the epithelium is no longer uniform owing to the formation of buds which extend into the underlying stroma. A distinct layer of cornified cells is present on the surface of the epithelium.



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Smith, Basset & Williams[15] reported very low concentrations of progesterone in the blood of mares during prolonged oestrus. This may be the reason for the continuous trickle of FSH, the progesterone level in the blood being too low to block the FSH releasing hormone. The small follicles in the non-cycling ovaries of these mares may be sufficiently active and produce sufficient oestrogens to bring the mares on heat and to stimulate the endometrial and vaginal changes.

Two types of follicular atresia were found. The one type occurred in small follicles, less than 5 cm in diameter, in which the theca layers had not yet differentiated into theca interna and externa. In these cases there was a fibroblastic invasion of the follicular walls which ultimately obliterated the antrum. The second type of atresia was seen in follicles over 5 cm in diameter, in which differentiation between the two thecal layers had been completed. In these atretic follicles a hyaline band developed between the theca interna and the stratum granulosum. In the process of atresia this hyaline band contracted, thus ultimately obliterating the antrum of the follicle to form a *corpus fibrosum atreticum*.

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A NECROTIC STOMATITIS-NEPHROSIS SYNDROME IN CATTLE IN RHODESIA

J. A. LAWRENCE*

SUMMARY.

A syndrome is described in cattle in Rhodesia, which is characterized by stomatitis, nephrosis and a disturbance of circulating neutrophils. The aetiology has not been established but there are grounds for suspecting that it is a Hyalomma tick toxicosis, similar to sweating sickness.

INTRODUCTION

In 1966 a distinctive disease syndrome, characterized by necrotic stomatitis, nephrosis, and a disturbance of circulating neutrophil leukocytes, was recognized in cattle in Rhodesia. An account of the condition was presented at the Annual General Meeting of the Rhodesian Veterinary Association on 12th December, 1966, and the paper was reproduced in the Newsletter of the Veterinary Research Laboratory in 1967. Since 1966 the condition has been diagnosed on a number of occasions, but the aetiology has not been established definitely. This paper serves to present the first published description of the condition, and to recount the investigations that have been made into the aetiology.

THE DISEASE

Epizootiology

Outbreaks have been widely scattered along the central watershed of Mashonaland, in the area lying between 30° 30′ East and 32°30′ East, and 17°00′ and 18°30′ South. All properties affected have been more than 1200 m above sea level. Outbreaks have been confined to the period of the main summer rains, from the latter half of December to March. Five outbreaks were diagnosed in 1966, and two minor outbreaks in 1967. Only one further outbreak was reported up to the end of December, 1971, when five outbreaks were confirmed during the 1971/72 season. Retrospective consideration suggests, however, that several outbreaks reported in the area between 1967 and 1972 and diagnosed on clinical grounds as mucosal disease, in fact have been the syndrome under consideration.

In most cases outbreaks have involved European-owned beef cattle, of both exotic breeds and exotic/indigenous cross-breeds. One outbreak involved a pedigree Ayrshire dairy herd. Age incidence has ranged from six months old upwards. In 1966 all cases seen were in animals two years old or older, but in 1971/72 most cases involved animals between one and two years old. All outbreaks have involved cattle grazing on veld or pasture. In general, affected herds have been well managed, in good condition and free from other diseases. Tick control has been good on most properties, with the exception of control of *Hyalomma* spp., which are widespread in the area and have been present in all affected herds in which they have been sought.

The morbidity rate has usually been low, although in two instances 10% or more of the affected herd was involved. In some outbreaks only one animal was affected. On properties where a number of cases have occurred, they have always been confined to one herd on the farm, although on some affected farms there were other herds of the same age group present in other paddocks. In most cases all the affected animals have become sick within a period of a few days, and once the cattle had been removed to fresh grazing, no new cases were detected. On one property the condition reappeared when another herd was moved into the affected paddock in March, one month after the initial outbreak, but did not recur when the same herd was put back into the paddock in April. On one property the condition appeared in one paddock in two successive years, but on most properties there has been no recurrence of the disease in subsequent seasons. On two properties with a high morbidity rate in the 1971/72 season, cases continued to occur over a period of two weeks, although the herd was moved into one or two different paddocks during this time. On both these properties, however, the paddocks involved were small (± 50 ha) and in close proximity to each other.

Clinical Signs

The onset of illness is sudden. In herds which are not intensively supervised affected animals may not be seen until the disease is well advanced, or they may be found dead. For this reason the earliest signs have been studied in a few animals only. They consist of a febrile reaction (up to 42°C) and erythema of the buccal mucosa.

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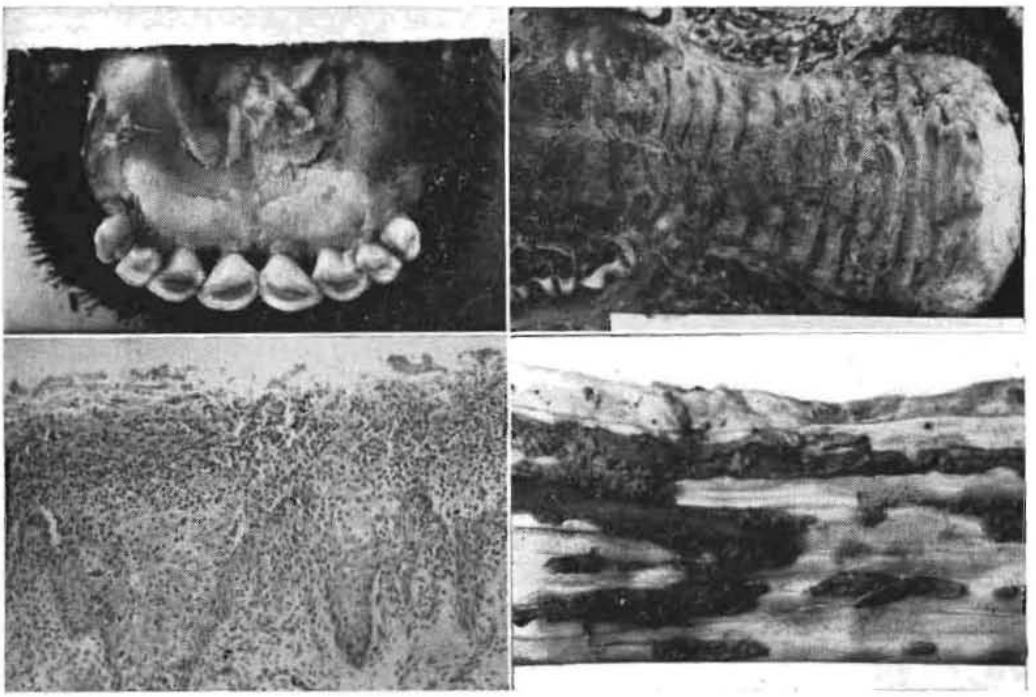

Fig. 1: Lower jaw, showing severe diphtheritic stomatitis.

Fig. 2: Palate, showing severe stomatitis with circular lesions of secondary fungal infection.

Fig. 3: Section of buccal epithelium, showing superficial necrosis. H & E.

Fig. 4: Oesophagus, showing longitudinal ulcers.

Within 24 hours the temperature becomes normal or subnormal, depending on the severity of the disease process. In one confirmed case the buccal erythema gradually diminished over a period of a few days, but in most cases superficial necrosis of the buccal mucosa develops rapidly, and involves most or all of the oral structures—tongue, cheeks, gums, lips—and occasionally the nostrils. The mucosa becomes white and dull, then begins to slough over large areas and becomes discoloured and foul smelling. Under the sloughing epithelium the exposed tissue is red but usually not haemorrhagic or ulcerated. At this stage the animal is dejected and often stands with head lowered, mouth open, tongue protruding and jaws working, with a moderate degree of salivation. If the nostrils are involved, there may be a small amount of muco-purulent nasal discharge, with crusting of the muzzle. There is loss of appetite, and often refusal to drink water, although in one closely observed herd polydypsia and polyuria were observed in the early stages. In a few cases there is evidence of abdominal pain and diarrhoea, while others pass small quantities of dark, loose faeces. Some animals become aggressive. It is at this stage that most cases are detected.

The ensuing course varies considerably. Some animals die within 24 hours. Others undergo progressive dehydration and starvation, with sinking of the eyes and hollowing of the flanks, and may die in three to five days, or may recover slowly. In the absence of secondary infection, the buccal epithelium may return to normal in a week, but loss of condition may be severe and convalescence prolonged. The final mortality rate is between 75 and 100%.

Clinical Pathology

Blood samples have been collected from a number of clinical cases at various stages of the disease, but serial samples have been available from only two animals on one property.

Blood urea levels are invariably raised at the time that symptoms appear, in some cases to above 300 mg/100 ml. In one

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apparently mild case the level was 50 mg/100 ml on the day following the appearance of symptoms, and had returned to normal two days later.

Haematological examination usually reveals a high packed cell volume—evidence of haemoconcentration owing to dehydration—but no abnormalities of red blood corpuscles. There is usually a moderate relative leukopaenia. The differential leukocyte count reveals abnormalities in the neutrophil leukocyte series. In some cases the percentage of neutrophils is within normal limits, but there is a marked shift to the left and metamyelocytes form an appreciable proportion of the total. In other cases normal neutrophils may be completely absent from the circulating blood. In such cases there are considerable numbers of toxic neutrophil myelocytes and metamyelocytes present, up to 60% of the total leukocytes. These cells are moderately large with round, irregular or indented nuclei containing dense chromatin, often not homogeneous and sometimes obviously clumped. The cytoplasm is plentiful and variable in character, pale or darkly basophilic, coarse or relatively fine in texture, sometimes granular, sometimes vacuolated and often containing moderate numbers of small, scattered acidophilic granules. The cytoplasm is strongly peroxidase-positive, confirming the granulocytic nature of the cells. Similar cells may be present in small numbers in cases with normal neutrophil types. In two animals examined the day following the detection of illness, and two days later, the percentage of toxic juvenile neutrophils had undergone a threefold increase, although one of the animals had begun to show signs of recovery by the third day. There is usually an eosinopaenia.

Table 1 gives the mean blood values for seven animals showing severe clinical illness.

Table 1: MEAN BLOOD VALUES FOR SEVERE CLINICAL CASES

	MEAN	RANGE
Urea (mg/100 ml)	207	70— 300
PCV (%) (4 only)	49	43— 56
White blood corpuscles (per mm³)	13 400	6 300—22 400
Neutrophils (%)	24	0— 64
Toxic juvenile neutrophils (%)	25	0— 60
Lymphocytes (%)	44	17— 75
Monocytes (%)	7	2— 18
Eosinophils (%)	0	0— 2
Basophils (%)	0	0

Table 2 shows the progressive changes from the second to the fourth day following the detection of illness in one fatal and one apparently mild case. The mild case appeared to be recovering but succumbed two weeks later, possibly as a result of secondary infection.

Table 2: SERIAL BLOOD VALUES FOR TWO CLINICAL CASES

	FATAL CASE		MILD CASE	
	Day 2	Day 4	Day 2	Day 4
Urea (mg/100 ml)	130	260	50	30
PCV (%)	47	48	36	31
WBC (per mm³)	12 000	8 900	10 800	12 500
Neutrophils (%)	0	0	18	44
Toxic juvenile neutrophils (%)	15	51	2	9
Lymphocytes (%)	81	44	60	44
Monocytes (%)	2	5	3	1
Eosinophils (%)	2	0	17	2
Basophils (%)	0	0	0	0

Pathology

In animals that die or are destroyed during the early stages of the disease *post-mortem* examination reveals extensive hyperaemia, necrosis and sloughing of the buccal epithelium (Figs 1 and 2). Histological examination reveals degeneration and necrosis of the superficial layers of the epithelium, while the stratum germinativum is usually intact (Fig. 3). In some cases, however, probably owing to secondary bacterial infection, ulceration occurs, and histological examination reveals necrosis of all layers of the epithelium and a marked inflammatory reaction in the underlying tissues. Secondary fungal infection is occasionally noted. In animals surviving for a week or more the buccal epithelium may be almost normal.

Pharynx and epiglottis may occasionally be hyperaemic with thickening or superficial necrosis of the mucosa. The oesophagus is involved in most cases, there being either thickening of the mucosa, or diffuse diphtheritic necrosis, or longitudinal ulcers (Fig. 4). The fore-stomachs are usually involved. In some cases hyperaemia of the mucosa is the only macroscopic lesion, although necrosis of the superficial layers of the epithelium can be detected histologically. In other cases necrosis and sloughing in all three stomachs is obvious macroscopically. In the abomasum and small intestine there is patchy hyperaemia of varying degree, sometimes quite intense, but no evidence of

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necrosis. Varying degrees of catarrhal enteritis may be detected macroscopically or histologically.

The kidneys are consistently affected: moderate to marked pallor of the cortex and, occasionally, perirenal oedema are noted. Histological examination reveals extensive, severe hyaline degeneration or coagulative necrosis of the convoluted tubule epithelium. In early cases there is no cellular reaction, but in cases of a few days standing there is proliferation of interstitial cells and an interstitial infiltration with mononuclear leukocytes.

The liver is usually enlarged and friable and often is mottled, with slight orange discolouration. Histological examination reveals hyperaemia, moderate fatty change, occasional necrosis of scattered individual parenchymal cells or small groups of cells, and sometimes bile stasis. Low grade fibrinous pericarditis, or fibrin clots in the pericardial sac, are sometimes seen, and subepicardial and subendocardial haemorrhages are common.

Histological examination of the adrenal cortex sometimes reveals hyperaemia, focal haemorrhage, degeneration of cells, and quite commonly the presence of small, brightly eosinophilic globules in considerable numbers in the cytoplasm of the cells of the zona glomerulosa.

No macroscopic or microscopic abnormalities have been recorded in lungs, spleen, lymph nodes or brain. Bone marrow has not been examined.

Diagnosis

By definition, diagnosis of the syndrome depends on the demonstration of stomatitis, raised blood urea, and disturbance of the circulating neutrophil leukocytes. This may be too narrow a definition of the syndrome. Cases have been encountered on several occasions which fulfilled two out of the three criteria. For example, in January 1966 an outbreak was investigated in which stomatitis and uraemia were outstanding features. Some animals also showed jaundice and ascites, and histologically marked degenerative changes were noted in the liver. Crusting and sloughing of the muzzle were commonly seen, and one animal showed skin lesions similar to sweating sickness. Nevertheless, no abnormalities of the circulating neutrophil leukocytes were noted in three animals examined haematologically, other than a moderate shift to the left in one. In another instance an animal undergoing a febrile reaction and hyperaemia of the buccal mucosa, as well as slight skin lesions on neck, dewlap and perineum, had a blood urea with normal limits but a differential leukocyte count of only 3% normal neutrophils and 9% toxic juvenile forms. This animal recovered uneventfully. In the absence of positive information on the aetiology, it is not possible to say whether these cases were atypical or incomplete manifestations of the same disease process, or were completely unrelated.

At this point it must also be noted that at least two animals reported as being early cases of this syndrome on the grounds of febrile reaction and hyperaemia of buccal mucosa, developed into typical cases of sweating sickness within 24 hours.

Treatment

No treatment has been found to be effective in severe cases, and, as it appears that the most significant lesion is nephrosis, it is unlikely that any treatment will succeed. Occasional less severe cases survive without treatment, but as a rule supportive antibiotic therapy and nursing are indicated. Blood urea estimation should prove a useful prognostic aid.

AETIOLOGY

At intervals various attempts have been made to establish the aetiology of this condition, without success. The investigations may be described under three headings.

Poisoning

The circumstantial evidence in the earliest outbreaks investigated was very suggestive of acute poisoning. Chemical estimations of liver and kidney from a number of animals revealed no arsenic, lead or mercury. Spectrographic examination of ruminal and abomasal contents from two animals revealed no trace of heavy metals. Ruminal and abomasal fluids from six cases were administered to sheep and guinea-pigs without any ill effects. On one occasion 1 litre rumen fluid from an animal that died after an illness of only 24 hours produced no clinical effect when dosed to a lamb weighing 15 kg, and blood urea estimation revealed no evidence of subclinical kidney damage. In the majority of outbreaks the paddocks in which the cases occurred were inspected carefully by the owner, and on several occasions by the author

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and by a botanist On no occasion was there any evidence of agricultural or other chemical, industrial or household refuse or any other substances likely to be toxic. Toxic plants that were present were those common in the area and not likely to cause the syndrome under investigation, and there were no uncommon known toxic plants, nor any unusual plants with evidence of having been grazed.

Infection

Although the epizootiological features of the condition did not suggest an infectious agent, several attempts were made to investigate this possibility. Suspensions of liver, spleen and buccal epithelium from two cases were inoculated into six-month-old calves by the subcutaneous route and by gum scarification, without effect. Similar suspensions from three cases were inoculated into mice and guinea-pigs. A few of these animals died from a Pasteurella infection that had not been detected on bacteriological culture of the original specimens, but the remainder was unaffected.

Bacteriological examination of liver and spleen from a number of cases revealed only the usual *post-mortem* contaminants. Mucosal lesions were often heavily contaminated with secondary bacterial or fungal invaders. Suspensions of liver, spleen, kidney and buccal epithelium from two cases were inoculated on to bovine calf kidney cultures, but no cytopathic effects were detected. Electron microscopic examination of necrotic buccal epithelium failed to detect virus particles.

Immunodiffusion techniques using convalescent serum and suspensions of tissues from affected animals yielded negative results.

Tick Toxicosis

As investigations proceeded, certain points of similarity between this syndrome and sweating sickness became apparent. Accordingly, attempts were made to collect Hyalomma ticks from outbreaks occurring in 1971/72. Attempts were limited to properties on which there was a relatively high incidence of the condition. On two properties prolonged blanket dragging of the paddock in which cases had occurred, and of adjacent paddocks, failed to recover *Hyalomma* spp. or indeed any cattle ticks at all. Attempts were then made to collect ticks off the cattle. Five unengorged *H. rufipes* females were collected from a bovine dead of the disease on one property, and five unengorged females and seven unengorged males were selected from a collection of ticks taken from healthy cattle on a second property involved in an outbreak. These ticks were placed on the tail brush of a nine-month old calf which had been maintained tick free throughout its life. Of these ticks, two females engorged fully and two partly. No clinical illness developed and there was no increase in blood urea and no significant alteration in the circulating leukocytes in the experimental host. A suspension of ticks collected from healthy cattle on the second property was inoculated on to calf kidney cultures and tested by immunodiffusion against convalescent serum, with negative results.

DISCUSSION

A search through the literature has revealed a description of only one condition resembling this syndrome, i.e. the New Zealand mucosal disease-like syndrome described by Salisbury *et al*[6]. This condition is afebrile, and is characterized by epithelial lesions in the buccal cavity and oesophagus, and severe necrosis of the renal cortical tubules. No significant changes have been noted in the leukocyte count. A cytopathogenic agent was isolated from affected cattle which was neutralized by mucosal disease virus diarrhoea antiserum. Nevertheless, it was considered that the renal necrosis was the primary lesion of the disease and that this may have resulted from the ingestion or absorption of a potent nephrotoxin. Thornton, Shirley & Salisbury[7] showed that an extract of *Aspergillus fumigatus* was nephrotoxic when administered intravenously to mice and sheep, and suggested that the syndrome was more probably due to a fungal toxin than to a virus. This has yet to be confirmed. If a fungal toxin is responsible for the condition in Rhodesia, it must originate from the natural grasses. The seasonal incidence of the condition is compatible with active fungal growth, coinciding as it does with warm, humid weather. The very low morbidity of the condition in Rhodesia, in contrast to the high morbidity reported in New Zealand, is not entirely consistent with a hypothesis of fungal infection of natural pasture.

Poisoning by plants, toxic in their own rights, can be discounted on the ground of the wide scattering of affected properties, with very different vegetation types, and the seasonal incidence. Plant poisoning is

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not common in Rhodesia during the height of the rainy season, as the normal fodder grasses are abundant and livestock seldom eat toxic plants at that time. Poisoning by unnatural chemical substances can also be discounted, on the grounds of the wide distribution of outbreaks, the low morbidity and the strict seasonal incidence. Certain mercury salts are corrosive to mucous membranes and are nephrotoxic, but there was no evidence of mercury in the specimens examined.

The possibility of an infectious agent, particularly a virus, cannot be discounted because of failure to demonstrate transmission, the presence of a virus or an antibody response. The epizootiological features of the condition are not incompatible with an infectious disease, particularly of an arthropod-borne, non-contagious nature. By contrast, the pathological features of the condition are more suggestive of a toxic agent than of an infectious agent.

In the author's opinion the most probable cause of the disease is a toxicosis caused by a *Hyalomma* species. This hypothesis is based primarily on the points of similarity in the clinical, pathological and epizootiological features of this syndrome and sweating sickness, which is a toxicosis caused by *H. truncatum (H. transiens)*. Sweating sickness, as described by Neitz [4], is mainly a disease of young calves, although all age groups may be affected. It is characterized by an initial, transient, febrile reaction, inflammation and superficial necrosis of buccal, nasal and pharyngeal mucous membranes and an extensive eczematous dermatitis. The disease is associated with certain localities and has a marked seasonal incidence, most cases occurring from January to March. Histological examination of the buccal mucosa reveals that the deepest layer of epidermis is often intact. Kidney lesions, described as a glomerulonephritis, have also been recorded and there is sometimes evidence of degeneration of the convoluted tubules [2]. Eosinophilic globules in the cytoplasm of cells in the zona glomerulosa of the adrenal cortex are commonly seen but are not considered specific—J. D. Smit (Veterinary Research Institute, Onderstepoort; personal communication). There is no published record of the haematological changes in the condition. Local experience, however, has shown that in at least some cases there is a marked shift to the left in the circulating neutrophil series inasmuch as the metamyelocyte stage and occasional toxic neutrophil precursors may be seen.

The points of similarity between the syndrome and sweating sickness are numerous and significant. Although Hyalommas have not been noted on all affected animals, for want of looking, no outbreaks have occurred in herds where Hyalommas were known not to be present, and in all but one case these ticks have been found on the affected animals when sought. On two properties, however, where the ticks had been carefully examined, the only species recovered were *H. rufipes*, and *H. truncatum* was not found. It is possible that this syndrome is a *H. rufipes* toxicosis, and is quite distinct from sweating sickness, which is a *H. truncatum* toxicosis. The detection of cases falling between this syndrome and classical sweating sickness is suggestive that there may be a spectrum of disease attributable to *Hyalomma* species in general, in which damage to skin, upper alimentary and respiratory mucous membranes, renal cortical tubules, and neutrophils and their precursors may occur in varying degrees of severity. There is already evidence that *Hyalomma* species may cause toxicoses other than classical sweating sickness [5] but to date nothing resembling the syndrome under discussion has ever been described.

On the assumption that the condition is a Hyalomma toxicosis, a possible explanation for the very low morbidity, and the absence of evidence of an age immunity, which is in contrast to sweating sickness, may be found in the fact that in most cases the disease runs a short and fatal course. It is likely that in most cases the causative ticks would not have time to engorge before the death of its host, and that the agent producing the toxicosis in effect would be almost as lethal to the parasite as to the bovine host. In some way the agent must be able to persist in the population, but because of its lethal attributes the population of responsible ticks would always remain at a low level.

Confirmation of this hypothesis concerning the aetiology must depend on the experimental reproduction of the condition by ticks collected from properties involved in outbreaks. The situation has its precedent in the history of sweating sickness, in which *Hyalomma* species were suggested as the causal agents by the farmers themselves [1] but their rôle was not confirmed until 1954,

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when Neitz[8] was able to reproduce the disease experimentally. In the case of this syndrome, confirmation or rejection of this hypothesis may be long delayed: owing to the low incidence of the condition, suitable sources of ticks become available at very infrequent intervals. It is to be hoped that eventually the suspected ticks may be incriminated definitely or that another aetiological agent may be identified.

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The Director of Veterinary Services, Rhodesia, has given permission for publication of this paper.

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INFORMATION — INLIGTING

LOWERING CARCASS FAT IN BIRDS

Research on the carcass composition of broiler chicks could lead to leaner, meatier birds for the consumer and a cleaner environment for everyone.

In recent years, concern has grown about the quantity of animal fat consumed by humans. Moreover, the disposal of fat-contaminated water from poultry processing plants may cause pollution. Thus significant decreases in carcass fat would be an important contribution to cleaner water.

In four trials at State College, Mississippi, Agricultural Research Service scientists studied the effects of environmental temperature on fat, moisture and protein content of broilers. Temperature control proved to be decisive in determining carcass fat. As temperature decreased, carcass fat decreased significantly, along with a simultaneous increase in moisture content.

Other researchers have shown that an imbalance of several different amino acids may increase fat deposition. Chicks on a diet deficient in lysine had significantly more carcass fat than those fed diets with an adequate or excess supply of lysine.

Lysine is one of the more difficult amino acids to metabolize. Therefore, with the excess lysine supply, it is possible that the energy required for breaking down the lysine in the digestive system used up the additional energy available for fat deposition.

(**Agricultural Research**, Vol. 21, No. 3; (September 1972); U.S. Department of Agriculture, Washington, D.C. 20250. **Agricultural Report** No. 56. Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W. Washington, D.C. 20008, U.S.A.. Published by Dept. Agricultural Technical Services, Pretoria).

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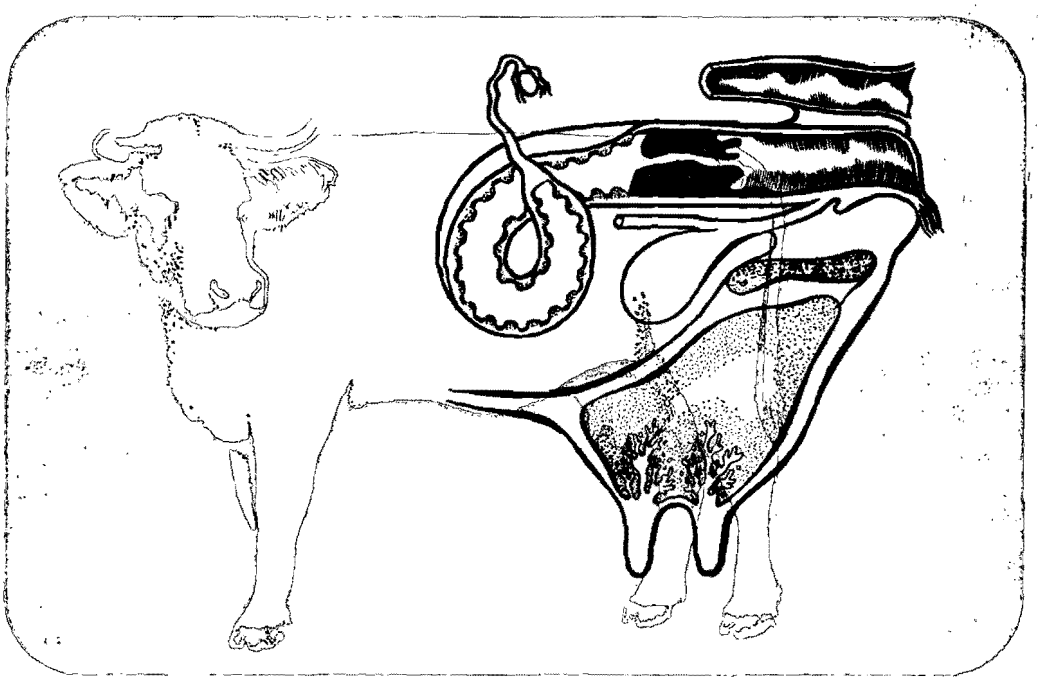

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Jl S. Afr. vet. Ass. 44 (2): 161—165 1973

FLUORESCENT AND NEUTRALIZING ANTIBODY RESPONSE TO INFECTION BY RIFT VALLEY FEVER VIRUS

A. PINI*, L. J. LUND** AND F. G. DAVIES**

SUMMARY

The indirect fluorescent antibody technique may be used as an alternative or confirmatory test for the detection of antibody to pantropic Rift Valley fever virus in sera from sheep and cattle and to Smithburn's neurotropic strain in sera from sheep. In cattle fluorescent antibody to Smithburn's neurotropic strain persists for only a short time.

INTRODUCTION

Coackley, Pini & Gosden [2, 3] reported that the neutralizing antibody titres of the sera of cattle to Smithburn's neurotropic strain of Rift Valley fever (RVF) virus are low. In sheep inoculated with this virus, either a high or a low antibody response may occur.

Animals having a low serum neutralizing index are still immune when challenged with a pantropic strain of RVF virus 19 to 28 months after inoculation. It appeared that the serum-virus neutralization test was insufficiently sensitive and/or that factors other than neutralizing antibody were playing an important rôle in the resistance exhibited by animals to challenge.

This paper describes the application and sensitivity of the indirect immunofluorescent technique for the detection of antibodies to pantropic and neurotropic strains of RVF virus.

MATERIALS AND METHODS

Virus

Pantropic RVF virus, strains Chu and 1119, isolated from naturally infected cattle, were stored at −20°C as first passage lyophilized sheep serum. When required, high titre virus was produced by inoculating hamsters intraperitoneally with 0,1 ml of infective serum. When the hamsters died, usually within 48 hours, the heart was removed and a 10% (v/w) suspension was prepared in Hank's balanced salt solution. This suspension was centrifuged and the supernatant used for animal inoculation.

The pantropic Kabete strain was used for the serological tests. This virus was stored at −60°C as a lyophilized 10% (v/v) dilution of infected mouse serum in 5% peptone water.

Tissue Culture

Tissue cultures of BHK 21 (C13) cells [5] were cultivated in Eagle's basal medium containing 10% tryptose phosphate broth (Difco) and 10% calf serum. Monolayers were prepared in tissue culture tubes containing coverslips as previously described [6].

Infectivity Titrations

Titrations were carried out by inoculating serial tenfold dilutions of virus intracerebrally in infant mice or intraperitoneally in adult mice. The titres were calculated by the method of Reed & Muench [7] and are expressed as the LD_{50} for either adult or infant mice.

Fluorescent Antibody Technique

The indirect method was used. Sheep and bovine gamma globulins were obtained

Table 1: RESPONSE OF CATTLE INOCULATED WITH VARYING CONCENTRATIONS OF THE PANTROPIC Chu STRAIN OF RVF VIRUS

Animal No.	MLD_{50} inoculated	Pyrexia	Viraemia	Antibody response 21 days p.i. SNI*	SFT**
7	2 500	+	+	6,0	4,0
8		+	+	5,2	3,4
9		+	+	5,2	2,8
10	250	+	+	6,0	2,8
11		+	+	6,0	2,8
12		+	+	4,7	3,4
13	25	+	+	5,2	3,4
14		+	+	5,2	2,8
15		+	+	6,0	3,4
16	2,5	0	0	2,1	1,6
17		0	0	0,5	0
18		0	0	0,2	0
19	0,25	0	0	0,5	0
20		0	0	0,5	0
21		0	0	0,2	0

*SNI = Serum neutralizing index.
**SFT = Serum fluorescent titre.

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by precipitating sera with an equal volume of 2,25 M sodium sulphate. For the production of the anti-species gamma globulins, cockerels were inoculated intramuscularly at weekly intervals for three weeks with 5 ml of an emulsion containing equal volumes of protein and Freund's adjuvant. The anti-sheep and anti-bovine gamma globulins were conjugated with fluorescein isothiocyanate (Baltimore Biological Laboratory) by the methods described [5]. The BHK 21 cells were infected with $10^{6,0}$ LD_{50} of the Kabete strain of virus when the cultures were 50% to 60% confluent. Coverslips were removed 24 to 32 hours later when, as had previously been established, more than 60% of the cells would show specific fluorescence. After fixation in cold acetone the coverslips were stained by the methods described [6].

Sera to be tested were diluted 1 : 10 (v/v) in a phosphate buffered saline and thereafter in fourfold dilutions. The serum fluorescent titre is expressed as the reciprocal of the highest $\log_{10}$ dilution of serum producing specific fluorescence.

Serum-Virus Neutralization Test

The method for determining the serum neutralizing index in adult mice was performed according to the standard procedures. A neutralizing index of $\geqslant$1,0 was regarded as significant.

Inoculation of Sheep and Cattle

Susceptible grade cattle and Merino or Corriedale sheep were used. Animals were selected on the basis of the results of preliminary tests in which their serum neutralizing indices were $\leqslant$0,7 and which in addition failed to produce specific fluorescence. After subcutaneous inoculation with 1,0 ml of virus suspension, rectal temperatures were taken twice daily. Temperatures higher than 102,7°F in cattle and 104,0°F in sheep were considered as indicative of infection.

To detect viraemia, blood samples were collected from each animal from the second to the fifth day post-inoculation (p.i.). Serum was separated and inoculated intraperitoneally into adult mice. Heart suspensions were prepared from the mice that died within seven days of inoculation and BHK 21 tissue culture cells on coverslips were infected. They were removed from the tubes when a cytopathic effect was observed and examined for the presence of intranuclear inclusion bodies [2].

In order to follow the immune response, the animals were bled after inoculation at intervals as indicated.

The animals were challenged by subcutaneous inoculation of 1,0 ml of 1% (w/v) hamster heart suspension containing not less than $10^{6,0}$ LD_{50} of virus. Immunity to challenge was assessed by the absence of both viraemia and pyrexia.

RESULTS

ANTIBODY RESPONSE TO PANTROPIC RVF VIRUS

Experiment 1

The response of cattle to the inoculation of varying concentrations of the pantropic Chu strain of RVF virus is presented in table 1.

Pyrexia and viraemia were demonstrated in all the animals which received 2 500, 250 and 25 adult mouse LD_{50} of virus but not in those inoculated with lower concentrations of virus.

Cattle inoculated with 2 500, 250 and 25 mouse LD_{50} developed high antibody titres as measured by serum neutralization and fluorescent tests. Only one of the three animals inoculated with 2,5 adult mouse LD_{50}

Table 2: ANTIBODY RESPONSE OF SERA OF CATTLE AND SHEEP INOCULATED WITH PANTROPIC 1119 STRAIN OF RVF VIRUS

Days p.i.	CATTLE			SHEEP		
	1	2	3	1	2	3
3	0/0*	0/0	0,4/0	0,6/0	0,4/1,0	0,6/0
6	0,1/2,2	0,4/1,6	1,4/1,0	0/2,2	1,5/2,2	1,9/2,2
12	0,1/2,8	5,0/2,8	1,5/2,8	5,0/4,0	5,0/4,0	5,0/4,0
30	5,0/2,8	5,0/3,4	5,0/2,2	5,0/4,0	5,0/4,0	5,0/3,4
62	5,0/2,2	5,0/2,2	5,0/2,2	5,0/4,0	5,0/4,0	5,0/2,8
152	5,0/2,2	5,0/2,2	5,0/1,6	5,0/2,8	5,0/3,4	5,0/2,8
274	5,0/1,6	5,0/1,6	5,0/2,2	ND**/2,8	ND/3,4	ND/2,8
365	5,0/2,2	5,0/2,2	5,0/1,6	5,0/2,8	5,0/3,4	5,0/2,2

*Serum-neutralizing index/serum fluorescent titre.

**ND = NOT DONE.

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developed a low antibody titre detectable by both tests.

Experiment 2

The antibody response of sheep and cattle inoculated with $10^{6.5}$ LD_{50} of the 1119 strain is given in table 2. All the animals were pyrexial and viraemic.

In both sheep and cattle specific fluorescence was demonstrable from the sixth day p.i. and reached its peak at about the 12th day. Between the 62nd and 152nd day p.i. antibody titres declined slightly in some of the animals, particularly the sheep. Neutralizing antibody in high titres was detectable by the 12th day p.i. and persisted at this level throughout the observation period of a year.

Experiment 3

The serum neutralizing indices and the serum fluorescent titres of both cattle and sheep 4 years p.i. with about $10^{5.0}$ adult mouse LD_{50} of the 1119 strain of pantropic RVF virus [3] are given in table 3.

Table 3: SERUM NEUTRALIZING INDEX AND SERUM FLUORESCENT TITRE FOUR YEARS P.I. WITH PANTROPIC 1119 STRAIN OF RVF VIRUS

Animals		SNI*	SFT**
Cattle	4	5,0	1,6
	5	5,0	1,6
	6	3,2	1,6
Sheep	4	5,0	1,6
	5	4,0	1,6
	6	4,0	1,6

ANTIBODY RESPONSE TO SMITHBURN'S NEUROTROPIC STRAIN

Experiment A

The Smithburn's strain of RVF virus in concentrations varying from 200 000 to 20 infant mouse LD_{50} was inoculated into groups of sheep. Pyrexia did not occur during a period of 14 days p.i. Isolation of virus was not attempted. Five weeks p.i. the immunity was challenged with $10^{6.0}$ adult mouse LD_{50} of the pantropic Chu strain of RVF virus.

The results giving the neutralizing indices and the fluorescent titres of each animal 21 days p.i. and the outcome of challenge are given in table 4.

After 21 days the animals inoculated with 200 000, 20 000 and 2 000 infant mouse LD_{50} had a significant neutralizing index $\geqslant 1,0$.

Antibody was detected by the fluorescent technique in all the sheep inoculated with 200 or higher mouse LD_{50}. A specific fluorescence was also demonstrable in one of the three animals inoculated with 20 infant mouse LD_{50} of virus. On the other hand, the challenge results showed that only those animals which had developed a significant neutralizing index were immune.

Experiment B

Three sheep and three cattle were each inoculated with $10^{6.0}$ infant mouse LD_{50} of the Smithburn's strain. There was no pyrexia during a period of 14 days p.i. Virus isolation was not attempted. Fifteen months p.i. the immunity was challenged with $10^{6.0}$ mouse LD_{50} of the pantropic Chu strains of RVF virus.

The fluorescent titres and the neutralizing indices were assessed at intervals and the results are recorded in table 5.

In sheep a rise in both types of antibodies was evident on the sixth day and the maximum response was obtained between the 12th and 30th day p.i. Towards the end of the observation period the antibody titres declined. The antibody response in cattle was generally of a lower order. A rise in the neutralizing index developed between the 12th and 30th day p.i. and it remained at a low level throughout the observation period. A rise in the fluorescent titre was detected on the 12th day p.i., remained at a low level temporarily, and then disappeared between the 61st and 365th day p.i.

Table 4: ANTIBODY RESPONSE AND CHALLENGE OF SHEEP INOCULATED WITH SMITHBURN'S NEUROTROPIC STRAIN OF RVF VIRUS

Animal No.	MLD_{50} inoculated	21 days p.i. SNN*	21 days p.i. SFT**	Challenge at 5 weeks p.i. Pre-challenge SNI	Challenge at 5 weeks p.i. Pyrexia	Challenge at 5 weeks p.i. Viraemia
7	200 000	4,5	4,0	4,0	0	0
8		3,4	2,8	3,6	0	0
9	20 000	1,8	1,6	1,8	0	0
10		3,8	2,8	3,8	0	0
11		2,1	2,2	2,0	0	0
12	2 000	1,6	2,2	1,4	0	0
13		0,9	2,2	1,0	0	0
14		1,6	2,2	1,8	0	0
15	200	0	202	0	+	+
16		0,5	2,2	0,4	+	+
17		0,4	1,6	0,3	+	+
18	20	0,3	1,0	0	+	+
19		0,3	0	0,3	+	+
20		0	0	0,3	+	+

*SNI = Serum neutralizing index.
**SFT = Serum fluorescent titre.

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Table 5: ANTIBODY RESPONSE OF SERA OF SHEEP AND CATTLE INOCULATED WITH SMITHBURN'S NEUROTROPIC STRAIN OF RVF VIRUS

Days p.i.	SHEEP 32	33	34	CATTLE 22	23	24
3	0/0	0/0	0/0	0,4/0	0,8/0	0,8/0
6	0/1,6	1,2/1,0	1,1/1,6	0,6/0	1,1/0	0,6/0
12	0,9/3,4	1,8/3,4	1,1/2,2	0,6/1,0	0,9/1,0	1,2/1,0
30	2,2/3,4	4,4/3,4	2,0/2,8	2,1/1,0	1,4/1,0	1,2/1,2
61	2,7/2,8	4,4/3,4	2,6/2,8	2,2/1,3	1,6/0	1,5/1,0
151	ND**/1,6	ND/2,2	ND/2,2	2,2/1,3	1,6/0	1,2/0
274	ND	3,0/1,6	ND/2,2	2,1/1,3	1,5/0	1,5/0
365	2,8/1,0	1,9/1,6	1,8/1,6	2,1/0	ND	ND
457	2,3/1,0	1,5/1,6	1,0/1,6	2,0/0	1,2/0	1,0/0

*Serum neutralizing index/serum fluorescent titre.
**ND = NOT DONE.

Fifteen months p.i. all the animals were immune, as judged by the absence of both pyrexia and viraemia following challenge.

DISCUSSION

The serum neutralization test in mice has been extensively used to assess the immune status of cattle and sheep to RVF virus [9].

Findlay [4] showed that neutralizing antibody in sheep inoculated with a pantropic strain of RVF virus is detected 12 days p.i. Our results with pantropic and neurotropic strains of RVF virus in both sheep and cattle confirm this finding. In some animals neutralizing antibody to the pantropic 1119 strain was already at a significant level on the sixth day p.i. In others, the response was delayed to the 12th day or later. The rise of neutralizing antibody to Smithburn's neurotropic strain took place in sheep between the sixth and 12th day p.i. and in cattle between the 12th and the 30th day p.i.

The immunofluorescent technique appears to detect earlier responses, specific fluorescent antibody being observed in the sera of most animals between the third and sixth day p.i. In cattle inoculated with Smithburn's neurotropic strain, however, the response was delayed and fluorescent antibody became detectable only between the sixth and 12th day p.i.

Neutralizing antibody to pantropic strains of RVF virus in the sera of cattle and sheep is usually at a high level [8, 9]. In an experiment with 58 cattle, Coackley, Pini & Gosden [2] found four animals with an unexpected and abnormally low neutralizing index. Neutralizing antibody to Smithburn's strain of RVF virus is at a low level, and although Coackley, Pini & Gosden [3] found that in cattle the maximum mean neutralizing index was 1,3 at four weeks p.i., these animals still possessed some degree of immunity when challenged 28 months p.i. In sheep inoculated with the same strain of virus, two types of antibody levels may be detected four weeks p.i.: a high level with a mean index of 5,1 and a low level with a mean index of 2,2 [1, 3]. The former was associated with viraemia in the inoculated animals [3].

In the present series of experiments the neutralizing indices to the pantropic 1119 strain of RVF virus were at a high level in both sheep and cattle. A comparable antibody response was detected by the indirect fluorescent antibody technique. Neutralizing antibody titres in sera from cattle and sheep inoculated four years previously with the same strain of virus were still high, whereas fluorescent antibody declined to a titre of 1,6. The two techniques also showed the same sensitivity in detecting antibody responses to the Chu pantropic strain of RVF virus in concentrations varying from 2 000 to 2,5 adult mouse LD_{50}.

In sheep inoculated with Smithburn's neurotropic strain, the serum neutralization test and the fluorescent antibody technique gave comparable results. The mean of the neutralizing index was 2,9 at 30 days p.i., it had declined to 1,6 at 457 days p.i., when the animals were still immune as judged by the results of the challenge experiment. It appears that in the presence of a low neutralizing index the fluorescent technique may be helpful in the interpretation of the significance of the result obtained by the serum neutralization test.

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In sheep inoculated with varying concentrations of the neurotropic strain, responses were detected by the fluorescent technique in all the animals which had received 200 infant mouse LD_{50} and in one of the three sheep inoculated with 20 infant mouse LD_{50}, although these virus concentrations were unable to induce any rise of neutralizing antibody. On challenge, these animals proved to be susceptible to the pantropic virus of RVF, suggesting that the antigenic stimulus was insufficient to elicit a protective response.

Fluorescent antibody to Smithburn's strain in cattle persisted only for short periods and could disappear as early as the second month p.i. In contrast, a low level of neutralizing antibody persisted for at least 457 days, when the animals were challenged and found to be immune.

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INFORMATION INLIGTING

ANIMAL HEALTH: THE UREA CONTROVERSY

Urea, a relatively new feed, is often blamed when infertility problems appear in dairy cows. A study made at Michigan State University indicates no connection between feeding urea to cows and poor calving records. The 5-year data collected disclosed that more than half the herds—54,1 percent—were getting urea from one or more feed sources. Percentage of herds on urea were: first year—42,8%, second year—55,8%.

Had urea been the culprit in reproductive failures, it was reasoned, a considerably higher percentage of problem herds would have been among those fed urea. However, adjusted calving intervals for herds fed no urea was 314,4 days and for herds fed urea during the 5-year period, a 315,7 day calving interval occurred. Average amount of urea fed from all sources was 0,2 lb per day; about half coming from corn silage. The remainder came from commercial supplements, high moisture corn and urea added to dry grain.

Neither the amount of urea fed, nor the number of years it was fed, affected breeding results in the 70 herds.

(**Successful Farming**, Vol. 70, No. 10 (September 1972); 1716 Locust Street, Des Moines, Iowa 50336. **Agricultural Report** No. 54, Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W., Washington, D.C. 20008, U.S.A. Published by Dept. Agricultural Technical Services, Pretoria).

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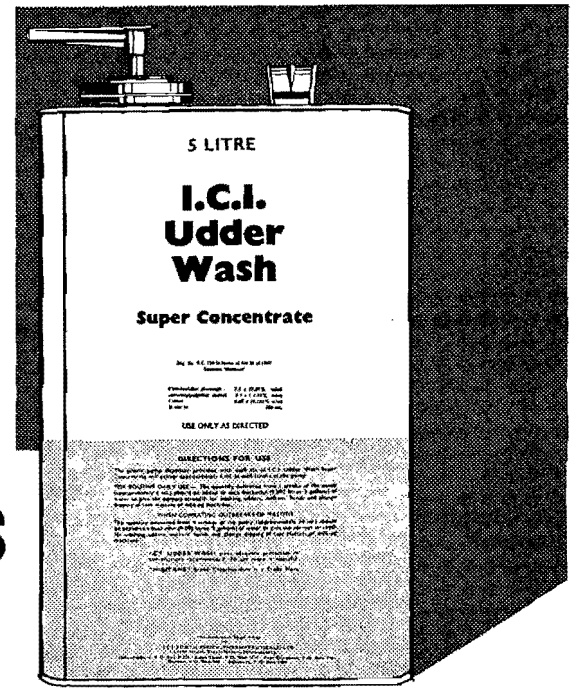

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Jl S. Afr. vet. Ass. 44 (2): 167—169 1973

RIFT VALLEY FEVER

3. VIRAEMIA IN CATTLE AND SHEEP
4. THE SUSCEPTIBILITY OF MICE AND HAMSTERS IN RELATION TO TRANSMISSION OF VIRUS BY MOSQUITOES*

B. M. McIntosh**, D. B. Dickinson* and I. dos Santos**

SUMMARY

Viraemia levels were determined in calves and lambs after inoculation of Rift Valley fever virus. In calves viraemia was detected from the first to fourth or seventh days; in lambs on the first three days. Maximum levels in both species were high: 7,0 log in a calf, 8,5 log in a lamb, as determined on the basis of 0,02 ml of blood per mouse inoculum.

The susceptibility of mice of various ages inoculated with Rift Valley fever virus by several routes and of adult hamsters by the subcutaneous route was compared. On the basis of the results, reasons are given to justify the use of 6-day-old mice and of adult hamsters in mosquito transmission experiments.

3. VIRAEMIA IN CATTLE AND SHEEP

Introduction

To be able to assess the rôle cattle and sheep might have in infecting mosquitoes with RVF virus, it is helpful, if not essential, to know the magnitude and duration of viraemia in these animals. When calves and lambs were inoculated with wild-type virus to produce viraemic animals to infect mosquitoes during experimental transmission studies, the opportunity was taken to determine viraemia levels and the results are presented in this paper.

Materials and Method

The blood samples were diluted 1/10 at the time of collection; serial tenfold dilutions of whole blood were prepared immediately and 0,02 ml inoculated intracerebrally into three-day-old mice.

Results

Table 1 shows the titres obtained in five calves and two lambs of from one to three months of age. Titres were highest on the second day; in calves the viraemia lasted for at least four to five days with traces of virus still present on the seventh day in one animal. Although the lambs gave very high titres on the second day, both gave low values on the third.

All the animals reacted with a febrile reaction, which was highest on the second or third day and usually only lasted for 24 hours. Calf 76 was destroyed *in extremis* on the sixth day after being prostrate for two days, but the remaining animals recovered after about one week. Other symptoms observed were anorexia, diarrhoea, a disinclination to move probably because of muscular pains, and weakness. The symptoms were generally mild and could easily escape observation, unless animals were under close supervision.

Discussion and Conclusion

From the viraemia levels recorded, calves and lambs would be a source of infection for mosquitoes over a period of up to five days, and it seems reasonable to assume that, because mortality and abortion occur in the adult of each species, animals of this age group would develop viraemia of a somewhat similar degree. The mildness of the symptoms in some of the animals showed that high viraemia frequently occurs in the absence of severe illness. This will mean that, in the absence of noticeable clinical signs, including abortion, and adequate diagnostic procedures, RVF virus could quite easily spread through several herds without its presence being detected. In this way considerable geographical dispersal of virus might occur before an outbreak was recognized. Because of their lower clinical response this covert dispersal is probably more applicable to cattle than sheep. This may partly explain the apparent simultaneous occurrence of outbreaks in widely separated localities during past epizootics.

*The studies and observations on which this paper is based were financed jointly by the South African Institute for Medical Research and the Poliomyelitis Research Foundation.

**Arbovirus Research Unit, South African Institute for Medical Research, Johannesburg.

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Table 1: RVF VIRUS CONCENTRATIONS IN THE BLOOD OF CATTLE AND SHEEP AFTER INOCULATION

Species	Viraemia* on days after inoculation											
	1	2		3		4		5	6	7	8	11
		a.m.	p.m.	a.m.	p.m.	a.m.	p.m.					
Calf 68	2,0	4,8	5,1	4,5	4,5	4,1		N	N	N	N	
,, 69	1,4	4,8	5,4	3,5	3,6	1,6		N	N	N	N	
,, 70		5,9	5,5	4,6	4,3	2,5		1,5	N	N		N
,, 71		6,4	7,5	5,4	5,4	4,3		2,4	1,0	0,5		N
,, 76				6,4		5,5	4,8	3,8				
Lamb 72	2,5	8,5		2,2						N		
,, 73	1,5	7,3		2,8						N		

*Viraemia expressed per 0,02 ml of mouse inoculum.
N = negative.

4. THE COMPARATIVE SUSCEPTIBILITY OF MICE AND HAMSTERS

Introduction

In transmission experiments with mosquitoes and arthropod-borne viruses the vertebrate animal used should, ideally, be of the same species as that involved in the natural transmission cycle. Obviously, this is not always possible; where substitutes must be used, their susceptibility relative to the natural host preferably should be known.

Unfortunately, the problem arises that there is uncertainty with regard to the quantity of a particular virus a mosquito will inoculate, so it is difficult to compare susceptibility to the bite of a mosquito with that determined by inoculation. Studies by Chamberlain, Kissling & Sikes[1] with eastern encephalitis virus indicated that a mosquito usually inoculates a very small dose of virus, something of the order of 10 LD_{50} lethal mouse doses, although exceptionally, individual mosquitoes inoculate 100 times this amount. Hence it would seem that the natural host must be of a high order of susceptibility for infection to succeed. From this it would follow that a relatively susceptible laboratory substitute should be used in transmission experiments. For practical reasons there is also much in favour of this, for great difficulty is often encountered in inducing mosquitoes to feed in the laboratory, with the result that some experiments have to be conducted with small numbers of mosquitoes, thus making it difficult to demonstrate transmission, even to highly susceptible animals.

A further problem concerns the route of inoculation used when susceptibility of the laboratory substitute is to be measured. When a mosquito feeds, saliva is apparently deposited interstitially before the fascicle succeeds in entering a capillary and feeding may be either intracapillary or interstitially from an extravasation into the tissues from a punctured capillary[2]. Hence, the virus may be deposited only interstitially, or interstitially as well as in the capillary, the former being equivalent to a subcutaneous and the latter to be a combined subcutaneous and intravenous inoculation. From this it would seem that susceptibility may validly be assessed subcutaneously but the animal should at least be moderately susceptible by this route.

Materials and Method

To compare the relative susceptibility of the species of animals which were used in the series of transmission tests with RVF virus described in the companion paper[3] a preparation of wild-type RVF virus was titrated in mice by various routes of inoculation and in hamsters by the subcutaneous route.

Results

The comparative titrations, expressed as in the previous section, are given in table 2.

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Table 2: TITRE OF THE SAME PREPARATION OF RVF VIRUS IN MICE AND HAMSTERS BY VARIOUS ROUTES OF INOCULATION

Species	Age	Route	Titres (log)
Mouse	6 days	IC	6,8
"	"	SC	4,6
"	Adult	IC	6,7
"	"	IP	3,7
"	"	SC	2,6
Hamster	Adult	SC	>7,5

IC = intracerebral.
SC = subcutaneous.
IP = intraperitoneal.

The virus preparation which yielded the same titre in adult and 6-day-old mice by the intracerebral route was two log lower in 6-day-old mice by the subcutaneous route and 4,0 log lower in adult mice by this route. Hamsters, inoculated subcutaneously, appeared to be even more susceptible than mice inoculated intracerebrally.

Conclusions

From these results it may be concluded that hamsters would be suitable for use in transmisison tests and would tend to favour the mosquito under test, whereas mice, 6-day-old, while suitable, would probably give a slightly conservative estimate of transmitting ability. The use of adult mice would severely lower the transmitting ability of the mosquito and it would be impractical and inadvisable to use this host with an efficient vector.

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ISOENZYME STUDIES IN ABORTING AND NON-ABORTING ANGORA GOATS

D. R. OSTERHOFF*, J. OP'T HOFF**, G. DE BEER* AND R. I. COUBROUGH***

SUMMARY

The following isoenzyme systems were investigated in aborting and non-aborting Angora goats: 6-PGD, G-6-PD, LDH, ADH, IDH, SDH and PGI.

No polymorphisms were found in any of these systems.

INTRODUCTION

The possible causes of large scale abortions among Angora goats in South Africa have been investigated by van Heerden [3] and van Rensburg [6]. The condition has been proved to be peculiar to the Angora goat, with abortions reaching up to 50% on some farms. Van Heerden [3] concluded that many adverse environmental factors were involved in precipitating abortion which then manifested as a result of a genetic weakness in these does.

From his endocrine studies on the aborting does, van Rensburg [6] suggested that the abortion appeared to be related to the suppression of the level of maternal adrenal function in response to increasing metabolic demands by the foetus.

Taking the past research a step further, the present study was initiated in an endeavour to characterize the genetic status of these animals by making use of enzyme markers. In a previous investigation [2] no differences of gene frequencies in blood groups and protein types between aborters and non-aborters could be established.

MATERIAL AND METHODS

A total of 158 animals, including Angora goats, Boer goats and cross-bred animals, was investigated for the red cell enzymes. The Angora flock used in the investigation was the offspring of stock originally purchased from affected farms. The terms "aborter" and "normal" doe, as defined by van Rensburg [6], are used to characterize the females studied. The liver enzyme studies were carried out on 70 liver samples, 64 obtained at slaughter, 6 by biopsy. Fourty-four liver samples were from purebred Angoras, including some known aborters, 27 were from Boer goat types and 9 from the cross-bred offspring.

Enzymes studied in red cell haemolysates included 6-phosphogluconate dehydrogenase, E C 1.1.1.44 (6-PGD), and glucose-6-phosphate dehydrogenase, E C 1.1.1.49 (G-6-PD), while lactate dehydrogenase, E C 1.1.1.27 (LDH), alcohol dehydrogenase, E C 1.1.1.1 (ADH), nicotine - adenine - dinucleotid - phosphate dependent isocitrate dehydrogenase, E C 1.1.1.42 (NADP-IDH), sorbitol dehydrogenase, E C 1.1.1.14 (SDH) and phosphoglucoisomerase, E C 5.3.1.9 (PGI) were determined from liver homogenates. Haemolysates and liver homogenates were prepared as described previously [4] and starch gel electrophoresis was carried out according to standard methods [4] with minor changes applied for the analyses of 6-PGD and G-6-PD. The gels were prepared in phosphate buffer pH 7,6; 0,005 M, the electrophoresis was performed in a refrigerated room at 4°C over a period of 5 h with 9 V/cm. In most of the liver enzymes the original method of Op't Hof [1] was used with minor changes in migration time, but in most cases the phosphate buffer system was adjusted to pH 6,5.

RESULTS

6-PGD: A total of 158 haemolysates was investigated. All the individuals showed an identical 6-PGD pattern consisting of one band (Fig. 1).

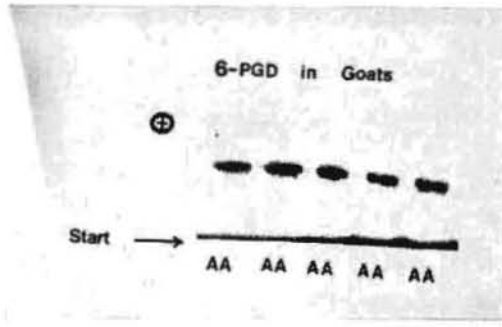

Fig. 1: 6-PGD in Angora Goats. AA: The common phenotype.

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G-6-PD: No difference was found between idividuals with regard to the G-6PD isoenzyme pattern. Using the phosphoglucomutase system [1], only one band could be identified in all 158 samples, whereas in another buffer system (PO_4, 0,005M, pH 7,6) multiple bands with quantitative differences within the bands were discernible (Fig. 2).

LDH: In 70 liver samples investigated no qualitative differences were found in certain individuals. The usual five-band-pattern was found in all the cases investigated (Fig. 3)

ADH: This enzyme was also investigated on 70 liver specimens, and the isoenzyme patterns were almost completely identical except for one pair of twins exhibiting a faster moving variant. In one individual the enzyme was completely absent (Fig. 4).

IDH: All liver samples showed the same pattern of three bands. In five animals, however, a faster moving variant was found (Fig. 5).

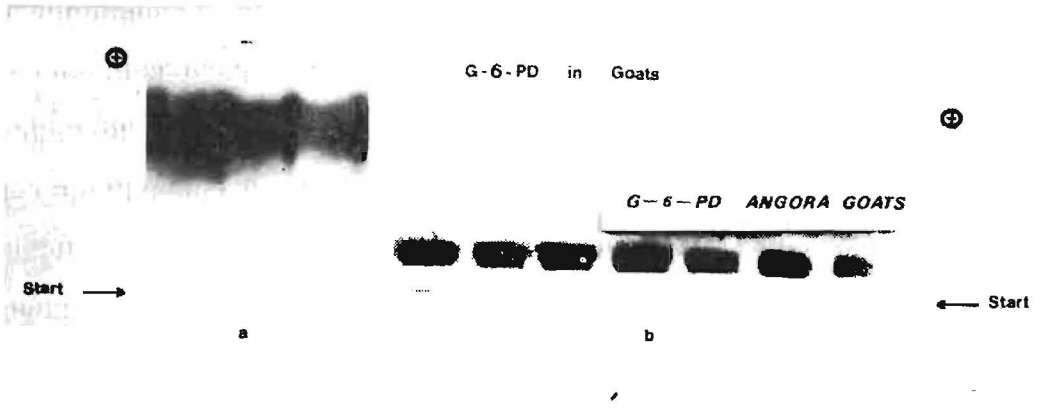

Fig. 2: G-6PD in Angora Goats. a: Multiple bands as found in the PO4 buffer and b: one band as found with the PGM buffer.

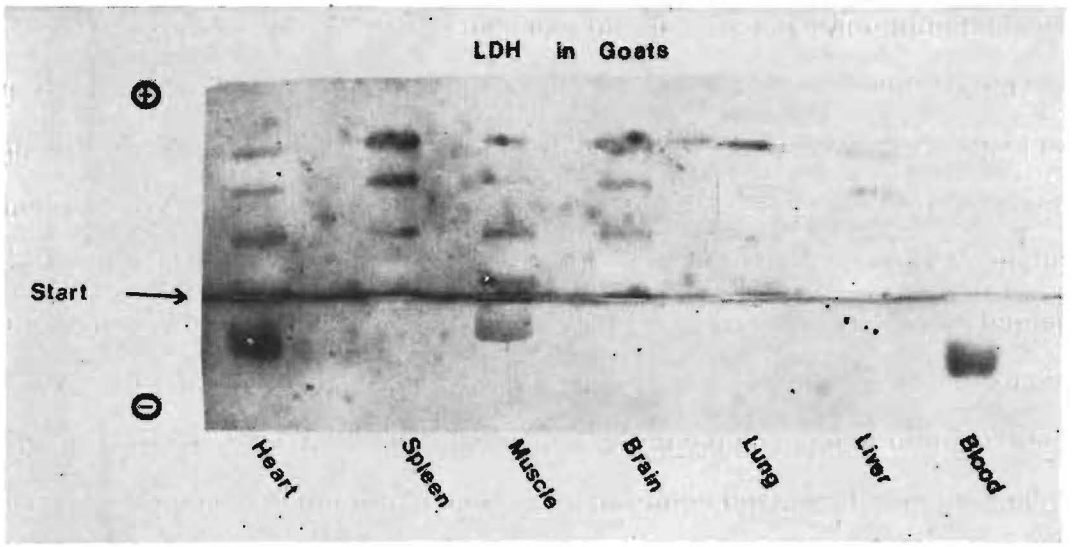

Fig. 3: LDH in Angora Goats. The usual 5 bands with tissue specific quantitative differences are clearly seen.

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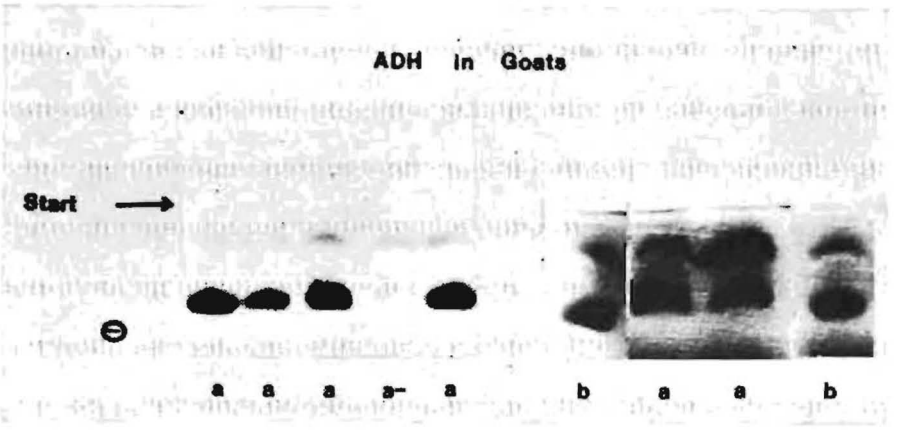

Fig. 4: ADH in Angora Goats. a: Represents the normal phenotype consisting of one band. The second band nearest to the start represents the LDH-5 band; a—: absence of ADH in one individual. b: ADH variant in twins.

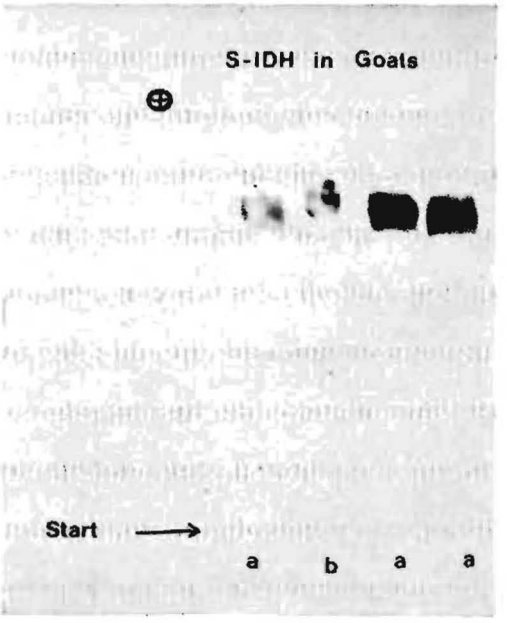

Fig. 5: S-IDH in Angora Goats. The common phenotype a, and the faster moving variant b.

SDH: This enzyme showed no variation in the 70 liver samples investigated (Fig. 6).

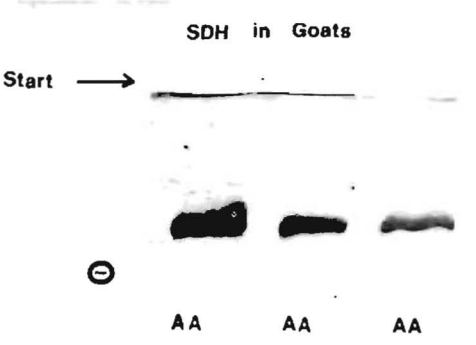

Fig. 6: SDH in Angora Goats. AA: The common phenotype consisting of one band.

PGI: In all the liver samples this enzyme showed no electrophoretic variation. One band was found on the cathodic side in all cases (Fig. 7).

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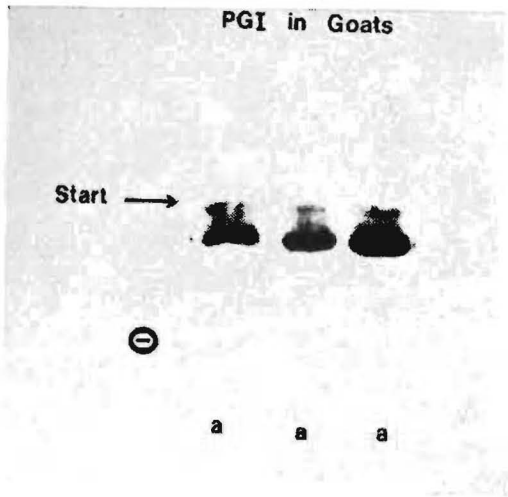

Fig. 7: PGI in Angora Goats. The common phenotype "a" is represented by one band.

DISCUSSION

No difference was found in the qualitative enzyme patterns in the purebred Angoras, the Boer goat type animals and their cross-bred offspring. The apparent quantitative variation shown in the case of LDH, and the faster moving variants found in the case of ADH and IDH, however, require more detailed investigation in relation to the three groups of animals studied. It was interesting to note that four of the faster migrating variants in IDH were found in cross-bred offspring, three of which had the same sire.

The results obtained thus far indicate that qualitative differences of these isoenzyme systems cannot be used to distinguish aborting from non-aborting goats. A quantitative differentiation in these systems and the investigation of additional isoenzyme systems, particularly tissue specific enzymes, may, however, reflect differences of diagnostic value.

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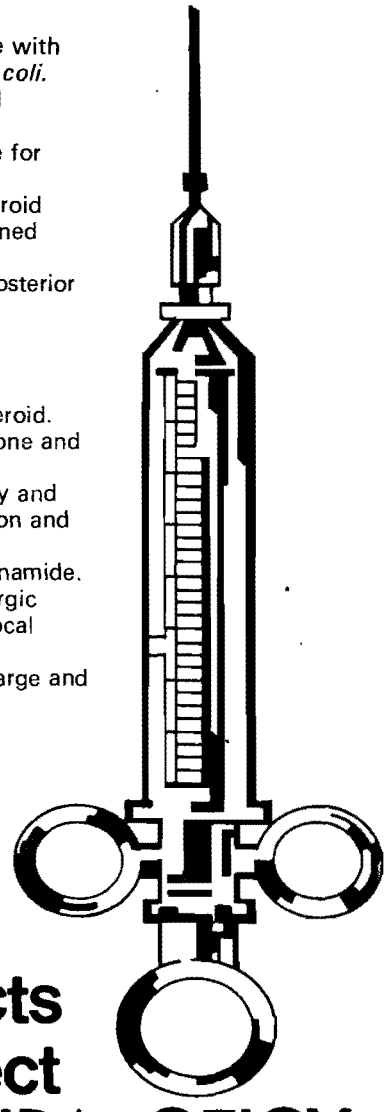

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EXPERIENCES WITH XYLAZINE HYDROCHLORIDE (ROMPUN, BAYER) IN THE CAPTURE, CONTROL AND TREATMENT OF SOME AFRICAN WILDLIFE SPECIES

E. YOUNG* AND I. J. WHYTE*

SUMMARY

The sedative, analgesic, anaesthetic and muscle relaxant properties of xylazine, its rapid onset of action, wide margin of safety, the absence of an excitement phase during induction and recovery, and its excellent potentiating effects on etorphine, fentanyl and phencyclidine, make it a most useful drug for the capture, handling, transport, taming, conditioning and surgical treatment of many African wildlife species. Recommendations as to dosage and indications for the various species are given in tabular form for ready reference.

INTRODUCTION

Xylazine hydrochloride, a thiazine-derivative, is a recently developed compound intended for parenteral administration which possesses sedative, analgesic, anaesthetic and muscle-relaxant properties.

The use of xylazine in captive wild animals has been fairly extensively reported [3, 4, 5, 8, 9, 11, 12, 15]. Only a limited number of publications, however, deal with the use of this compound in the capture or tranquillization of African mammals [7, 8, 11, 14, 15, 16, 19, 20], European deer [13] and sedation prior to clinical examination and treatment of the water buffalo [10].

The uses and pharmacological effects of xylazine, either alone or in combination with etorphine hydrochloride (M99, Reckitt), fentanyl (Janssen Pharmaceutica) or phencyclidine hydrochloride (Sernylan, Parke Davis), have been studied in 63 animals of 11 African mammal species. These include 8 lions *(Panthera leo)*, 2 spotted hyaenas *(Crocuta crocuta)*, 33 impalas *(Aepyceros melampus)*, 9 African buffaloes *(Syncerus caffer)*, 2 blue wildebeest *(Connochaetes taurinus)*, 1 waterbuck *(Kobus ellipsiprymnus)*, 1 eland *(Taurotragus oryx)*, 3 gemsbuck *(Oryx gazella)*, 1 kudu *(Tragelaphus strepsiceros)*, 3 red duikers *(Cephalophus natalensis)* and 1 steenbuck *(Raphicerus campestris)*. Useful information has been obtained and is presented in conjunction with results recently reported by other researchers.

USES AND EFFECTS OF XYLAZINE

Xylazine was administered as either a 2% or a 10% solution by manual intramuscular injection or made up into a solution containing 20—25% of the active compound which was then administered by means of projectile dart syringes.

Lion

The undesirable effects of muscle spasticity and convulsions which are often produced by the immobilizing agent, phencyclidine [2], can be counteracted effectively by the simultaneous or subsequent administration of suitable tranquillizers, including xylazine [19]. Free-roaming lions have been darted and successfully captured by using xylazine-phencyclidine drug mixtures. In addition, six lions captured with phencyclidine alone, subsequently received xylazine at a dosage rate of 0,5—0,7 mg/kg by intramuscular injection. The muscular rigidity and convulsions precipitated by phencyclidine were successfully controlled within 5 minutes of the administration of xylazine.

Landowska-Plazewska [11] and Sagner & Haas [15] have sedated lions with xylazine at dosage rates exceeding 6 mg/kg. We have found, however, that following immobilization with phencyclidine at 0,5 mg/kg, very low dosage levels of xylazine (about 0,5 mg/kg) produce profound anaesthesia and adequate analgesia in lions.

The respiratory rate in lions captured with phencyclidine decreased by an average of 44% within the first ten minutes. Following xylazine administration, breathing remained deep but became much more regular. In cases where the reduction in respiration rate may cause alarm, relief can be obtained by the intravenous injection of doxapram hydrochloride (Dopram-V, A. H. Robins Co.). This agent has marked analeptic effects on phencyclidine and xylazine treated lions [21].

Xylazine produced a considerable reduction in the heart rate of treated lions, which

*Division of Veterinary Services, Kruger National Park, P.O. Skukuza.

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THE DOSAGE OF XYLAZINE, USED ALONE OR IN COMBINATION WITH OTHER IMMOBILIZING AGENTS FOR DIFFERENT SPECIES OF AFRICAN MAMMALS

Species	Xylazine	Etorphine/ Phencyclidine	Indication/desired effect
Lion	0,5—0,7 mg/kg	Phen. 0,5 mg/kg	Relief of muscle spasticity and convulsions. Immobilization.
Hyaena	1 mg/kg	Phen. 1 mg/kg	Relief of muscle spasticity and convulsions. Immobilization.
Impala	0,87—8,37 mg/kg (ave: 3,26 mg/kg)	—	Sedation, handling, transport, acclimatization, surgery.
	65—86 mg	Etorph. 0,4—0,5 mg	Immobilization of adult animals.
Buffalo	0,20—1,25 mg/kg (ave: 0,52 mg/kg)	—	Sedation, immobilization (captive animals).
	300 mg	Etorph. 5 mg	Capture of adult, wild bull.
Blue wildebeest	1,3—2,6 mg/kg	—	Sedation.
Gemsbuck	200—330 mg	Etorph. 4 mg	Immobilization — adult wild animals.
	40—60 mg	Etorph. 3 mg	ditto
Eland	±0,6 mg/kg	—	Sedation.
	400—600 mg	Etorph. 4—5 mg	Immobilization — adult wild animals.
Kudu	±0,7 mg/kg	—	Sedation and transport.
	200—300 mg	Etorph. 3—4 mg	Immobilization — adult wild animals.
Red duiker	6—8 mg/kg	—	Limb amputations — local anaesthetic also used.
	5 mg/kg	—	Taming of wild animals.
"Mini antelope" species	20—25 mg	Etorph. 0.3—0,4 mg	Immobilization.

was more pronounced at higher dosage levels. At an average dosage rate of 0,5 mg/kg xylazine, the heart rate decreased by 38% within 5 minutes, and at a dosage rate of 0,7 mg/kg it decreased by as much as 54% within 3 minutes of injection.

Xylazine does not appear to exert any definite influence on the body temperature of lions. In this series, however, each lion received phencyclidine with or prior to xylazine and the general tendency of the body temperature to decrease slightly, except when the animals were exposed to direct sunlight, may have been due to the effects of the phencyclidine rather than the xylazine.

Hyaena

The centrally acting muscle relaxant effect of xylazine has also proved most useful in spotted hyaenas captured with phencyclidine. Xylazine, injected intramuscularly at a dosage rate of 1 mg/kg following the oral or intramuscular administration of phencyclidine at 1 mg/kg, not only relieved the muscle spasticity and convulsions, but also produced more satisfactory sedation.

Impala

This medium-sized antelope, which occurs in great numbers in the Kruger National Park and elsewhere in Africa, received most attention in these investigations. The uses and effects of xylazine will therefore be discussed in greater detail with regard to this species.

The 33 experimental animals, ranging in age from one month old to full-grown adults, received doses of xylazine varying from 0,87 to 8,37 (average: 3,26) mg/kg intramuscularly, delivered either by manual injection or by projectile dart syringe.

Animals were treated and sedated with

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Fig.· Impala, captured under veld conditions with Rompun alone.

xylazine for the purposes of handling and transport, surgical treatment, the capture of free-roaming animals (xylazine being used alone or in combination with potent analgesics) and for the taming and conditioning of newly captured individuals.

Adequate sedation for handling and transport was obtained with very low dosage rates. Very young lambs received 1,3 mg/kg, while juveniles and adults received similar, or slightly lower or higher doses of xylazine. All the animals reacted very favourably and could be handled and transported with the greatest of ease.

Several impalas were secured in sternal recumbency on a thick layer of hay in transport vehicles and subsequently transported over long distances without making use of the usual expensive crates. This method of transport could probably also be used for other species. The same precautions should be taken as for impalas transported under the influence of chloral hydrate [17] or other tranquillizing and anaesthetizing agents. The duration of xylazine's sedative effects is dependent upon the dosage used. Impalas were usually adequately sedated from about 2 minutes to 2 hours.

Xylazine has a lasting taming effect on impalas, especially when they are extensively handled while under its influence. Newly captured animals, sedated with xylazine, accept their artificial enclosures readily and its routine use can definitely contribute to successful adaptation to new conditions and the consequent reduction of losses [20].

The very deep sedation, pronounced muscular relaxation and profound analgesia produced by xylazine, present ideal conditions for surgery. At dosage levels varying from 2—4 mg/kg, it was possible to carry out laparotomy, oöphorectomy, nephrectomy and caesarian section on adult impalas. The use of local anaesthetics was not necessary, as the analgesic effect of xylazine proved to be adequate for the above-mentioned operations. The impala lamb, delivered by caesarian operation, showed temporary signs of depression, but soon recovered completely from these effects.

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Induction and recovery from xylazine is smooth, and its use is not characterized by an excitement phase. This is a very important advantage, as excited and recently operated wild animals may injure themselves with fatal results when overstimulated by tranquillizing or anaesthetizing drugs during recovery.

Xylazine may be used on its own or in combination with other and more potent analgesic agents to capture impala. Free-roaming impalas were darted and successfully immobilized with xylazine alone (Fig.) The darted animals showed the first signs of reaction to the drug from 45 seconds to 5 minutes (average: 2,6 minutes) after the intramuscular administration of xylazine; a faster reaction than this is very seldom observed with any other immobilizing agent. The earliest signs included drooping of the head and ears, torticollis (variable) and increasing signs of general depression, sedation and relaxation.

Muscle relaxation usually set in after about 2 minutes and lasted for 45 minutes or longer, depending on the dosage level. In spite of this effect, twitching of the musculature was frequently observed and was associated with fright reactions due to sudden noises. Posterior paresis usually became evident from 2—7 minutes (average: 4 min) after injection, and the animals immobilized in this series of experiments were generally recumbent after an average interval of 10,4 min. One adult ram weighing 53 kg was captured under veld conditions within 5 minutes of darting with 3,75 ml of a 10% solution of xylazine.

Other animals could be captured with lower dosages (i.e. 2,9—3,5 mg/kg), provided that the recumbent animals were approached quietly after sufficient time had been allowed to elapse for the drug to take full effect. If darted impalas were disturbed too soon, those which had received xylazine at dosages even greater than 5,5 mg/kg regained consciousness and were capable of running off. If left undisturbed, they again relapsed into an unconscious state. It was generally advisable to leave the darted animal undisturbed for at least 2—5 minutes after it had gone down, unless it was in lateral recumbency or was in need of assistance.

Impalas usually went down in sternal recumbency with their necks extended and chins resting on the ground. Nevertheless, torticollis was frequently observed. Some animals rolled over on to their sides, thereby increasing the risks of tympany, regurgitation and suffocation. Such animals had to be propped up on their briskets and retained in this position. Immobilized animals usually recovered and became ambulatory after 2—3 hours.

The lack of a suitable antidote for xylazine presents a serious disadvantage which can, however, be overcome by combining low dosages of this compound with fentanyl or etorphine (M99). The effects of these two very potent analgesics can be antagonized effectively by nalorphine hydrobromide (Lethidrone, Burroughs Wellcome) or cyprenorphine hydrochloride (M285, Reckitt). Pienaar [14] recommended xylazine, 65 and 86 mg, in combination with fentanyl, 8 and 10 mg, or with etorphine, 0,4 and 0,5 mg, for adult female and male impalas respectively.

The following effects of xylazine on impala have become evident during these investigations. The swallowing reflex is usually suppressed and the tongue paralysed. This effect makes xylazine an ideal immobilizing agent for the routine capture and examination of impala and other susceptible species for lesions of foot-and-mouth disease. At the same time, however, the copious salivation associated with xylazine administration cannot be controlled effectively and the necessary precautions should be taken to prevent suffocation from excessive salivation or regurgitation of ruminal contents [19]. The corneal reflex is one of the protective reflexes which is not usually affected by xylazine.

The respiratory rate is usually not markedly reduced in impalas treated with xylazine. Sometimes breathing does become slightly shallower and irregular during the first 3—5 minutes after administration. Impalas usually emit a grunting sound, a characteristic effect of xylazine in most wild mammal species so far studied.

Heart function is affected to a greater extent than respiration. An average decrease in the heart rate of about 40% is evident within 15 minutes of administration. In some individuals, the heart rate dropped by up to 50% in less than 3 minutes following intramuscular injection. According to the manufacturers, the intravenous injection of xylazine may cause a transient, moderate drop in blood pressure in horses, which is often preceded by a brief increase. Blood pressure could not be measured in impalas or any of the other animals in this series, but the superficial veins of some of the animals appeared

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much more prominent following the injection of xylazine.

Body temperature of treated individuals tended to rise slightly at relatively high ambient temperatures, and to decrease at lower temperatures. Nevertheless, xylazine does not appear to have as dramatic and disadvantageous an effect on the regulation of body temperature as the phenothiazine tranquillizers.

Concentrations of up to 25% xylazine have been used to immobilize impalas. Necrosis as the result of the use of such concentrated solutions has not been encountered.

In general, xylazine seems to be not only a very effective and useful drug for use in the capture, handling, transport, taming, conditioning and surgical treatment of impalas, but at the same time appears to be one of the safest pharmacological compounds to be employed for such a variety of purposes.

Buffalo

Seven buffaloes, about two to five years old and accommodated in the animal enclosures of the Veterinary Research Section in the Kruger National Park, were manually injected with xylazine after having been secured in an ordinary cattle crush. A 10% solution of xylazine was used. The dosage rate varied from 0,20—1,25 (average 0,52) mg/kg and the drug was administered intramuscularly. The following observations were made:

The first reactions (sedation, drooping of the head, paralysis of the tongue, salivation and grunting) were observed after 2—5 minutes. The onset of these reactions occurred more rapidly at higher dosage levels.

Posterior paresis developed 3—7 minutes after injection and the animals became recumbent after 4—23 minutes (average: 9,5 min). Successful handling of the animals during the initial stages of recumbency depended very much on the avoidance of excessive disturbance. Animals which had been left for a sufficient period to allow the drug to take full effect, lapsed into a deep sleep. It was impossible to interrupt the somnolent state of one animal which had received 1,25 mg/kg xylazine. It is important to assist such animals in order to prevent complications such as tympany, regurgitation and suffocation. The necessary attention should also be paid to the animals' heart rate, respiration and other physiological phenomena.

Specific attention was paid to the effect of xylazine on the temperature regulation of these buffaloes when exposed to direct sunlight and high ambient temperatures. It would appear that xylazine does not interfere with the heat regulation mechanism of captured animals to any significant degree. This is an advantage as the loss of heat regulating abilities is often an important mortality factor in newly captured animals [2, 7, 14, 19].

More than 50 free-roaming buffaloes were captured in Botswana for foot-and-mouth disease research using etorphine or fentanyl in combination with acepromazine maleate (Acetylpromazine, Boots) or azaperone (Stresnil, Janssen Pharmaceutica). In none of these animals was the same degree of relaxation of the tongue and pharyngeal musculature obtained as was the case with xylazine-treated buffaloes. This effect is very useful for successful inspection for foot-and-mouth disease and for sample collection.

When the above dosage rates were employed, the sedative, analgesic and muscle relaxant effects of xylazine disappeared after about 2—3 hours. The animal which had received the highest dose (1,25 mg/kg) was recumbent for more than 3 hours. From the above results it appeared that the buffalo is much more susceptible to the effects of xylazine than the impala.

In the capture of wild animals, the most important value of xylazine probably lies in its excellent synergistic and tranquillizing properties when used in combination with the potent analgesics, etorphine (M99) or fentanyl [14]. Two wild buffaloes were captured using different drug combinations. One adult bull was successfully captured and anaesthetized within 8 minutes of darting. Etorphine, 5 mg, and xylazine, 300 mg (about 0,5 mg/kg), were used as immobilizing agents. The effects of the etorphine were antagonized by the intravenous administration of cyprenorphine after about 30 minutes. The recovered animal, however, was still profoundly sedated owing to the effects of xylazine.

Blue wildebeest

Two young, tame wildebeest were manually injected with xylazine, at dosage rates of 1,3 and 2,6 mg/kg respectively. The first reactions appeared within 2 minutes. Posterior paresis was noticeable within 3 minutes and both animals were recumbent within 4 minutes of intramuscular injection. Neither animal was satisfactorily sedated, however, and in neither case was muscle relaxation sufficient. In spite of the relatively higher

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doses used, the wildebeest did not react as favourably as the buffalo and they regained their feet when they were approached. An adult wildebeest cow which had subsequently been darted with 500 mg xylazine, kept on running and could not be captured. More research is required to establish the optimal dose of xylazine, with or without specific additives, for the capture of free-roaming wildebeest.

Salivation was copious in the above-mentioned young wildebeest. The respiratory rate was reduced by 50% and the heart rate by 43% within 15 minutes after injection. The body temperature showed a steady increase when the animals were exposed to direct sun. The blue wildebeest, however, is known to control its body temperature by behavioural rather than physiological means. Owing to the dark colour of its coat and its poor ability to cool itself by evaporative heat loss [18], direct exposure to radiation from the sun would have raised body temperature, irrespective of whether drugs had been administered or not.

Waterbuck

Drug immobilization of this species has always been unsatisfactory [6]. The best results obtained to date in the Kruger National Park have been with a combination of etorphine and xylazine. An adult bull was immobilized very successfully within 10 minutes using etorphine, 3 mg (about 0,013 mg/kg), and xylazine, 300 mg (about 1,30 mg/kg). Pienaar [14] recommended xylazine 200 mg and 250 mg with etorphine 2 mg and 3,5 mg or fentanyl 40 mg and 50 mg for the capture of adult waterbuck cows and bulls respectively.

Gemsbuck (oryx)

In collaboration with Dr G. de Graaff and Messrs le Riche of the National Parks Board, two adult gemsbuck bulls were captured successfully in the Kalahari National Gemsbok Park, South Africa. They were recumbent within 8—11 minutes of darting from a moving vehicle with etorphine, 4 mg (about 0,19 mg/kg) and xylazine, 200—330 mg (about 1—1,6 mg/kg). These animals were satisfactorily relaxed and sedated, in contrast to gemsbuck captured previously with other drug combinations [1]. It was obvious, however, that the animals should be left quietly and not be disturbed by noise or handling before the full effects of the drug had been reached. Smuts [16] subsequently captured an additional 11 adult gemsbuck and eventually reduced the dosage of etorphine to 3 mg and that of xylazine to 40—60 mg. Even with these reduced doses of xylazine, equally good results were obtained. The reduction of the xylazine dosage apparently reduced recovery time and this is of considerable importance, especially when animals are to be released in unsafe surroundings. Animals which may not recover completely after etorphine reversal must be assisted until they are strong enough to fend for themselves.

Gemsbuck, immobilized with xylazine drug mixtures, did not show any undue struggling or excitement during the recovery phase. Xylazine was, without any doubt, found to be the best synergist for the potent analgesic, etorphine, in the chemical immobilization of gemsbuck.

Higher dosage levels of xylazine produced pronounced muscle relaxation, and it is envisaged that this drug may find a place in the preparation of animals of this species for surgical and other treatment. The above experiments also demonstrated the wide safety margin of xylazine.

Eland

Xylazine, 0,6 mg/kg, produced marked sedation in a young 250 kg eland bull within 8 minutes of intramuscular administration. Subsequent intramuscular injection of 2 mg etorphine produced a satisfactory anaesthetic effect which could be reversed by the intravenous injection of cyprenorphine.

Pienaar [14] and Smuts [16] recommended xylazine, 400 mg and 600 mg, with etorphine, about 4 mg and 6 mg, or with fentanyl, 50 mg and 70 mg, for the immobilization of adult eland cows and bulls respectively.

Kudu

Xylazine, 0,7 mg/kg, was found adequate to sedate an adult kudu bull effectively for handling and transportation without a crate. Hime & Jones [8] used an even lower dose (0,1 mg/kg) for sedation.

The effect of xylazine in the kudu was also characterized by grunting, increased salivation, and reduced respiratory and heart rates.

Adult kudu cows and bulls were captured with 200 mg and 300 mg xylazine in combination with 3 mg and 4 mg etorphine or 60 mg and 80 mg fentanyl respectively [14, 16].

The smaller antelopes

Limb amputations were successfully performed on red duiker which had received xylazine, 6—8 mg/kg, and local anaesthetic.

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In addition xylazine, 2,1 mg/kg, was found to be adequate for the splinting of a fractured leg of a steenbuck. In all cases, sedation and analgesia were satisfactory, but sudden noise had to be avoided as this caused temporary excitement and fright reactions in the treated animals.

Xylazine was found most useful in the taming of red duiker. Even the wildest animal could be tamed in one day if it had been treated with xylazine and handled patiently for the following few hours. The dosage used for this purpose was approximately 5 mg/kg but lower doses may be equally effective.

Very little published information is available on the sedation and chemical immobilization of the smaller antelope species. Xylazine has been used by other workers on steenbuck [15] and Maxwell's duiker *(Cephalophus maxwelli)* [8]. In adidtion, Pienaar [14] recommended 20—25 mg xylazine with 0,3—0,4 mg etorphine or with 5—7 mg fentanyl for the capture of adult animals of the smaller antelope species.

CONCLUSIONS

The main characteristics of xylazine, based on our experience of the use of this drug on 11 different African mammal species, may be summarized very briefly as follows:

1. Extremely rapid absorption after darting or manual intramuscular injection.
2. Rapid onset of sedation which generally lasts for a few hours.
3. No excitement phase during induction or recovery.
4. Marked taming effect on wild animals.
5. Promotes the acclimatization and successful adaptation of animals to captive conditions.
6. May be useful on its own or in combination with other drugs as an analgesic or anaesthetic for major operations including nephrectomy, limb amputation and caesarian section.
7. May be used for the chemical immobilization of some species (i.e. buffalo and impala), provided that adequate dosages are employed and that undue disturbances are avoided.
8. Possesses excellent potentiating effects on etorphine, fentanyl and Sernylan, which are frequently used for the chemical immobilization of wild animals.
9. Possesses an extremely wide safety margin. In some species optimal dosage may be exceeded more than tenfold without detrimental effects.
10. Xylazine usually causes a marked reduction of heart rate and has variable effects on respiration, but its effect on temperature regulation is minimal.
11. Its combined sedative, analgesic, anaesthetic and muscle relaxant properties and its wide margin of safety make it a most useful and exceptionally safe drug for the capture, handling, transport, taming, conditioning and surgical treatment of many wildlife species.

A summary of dosage rates, adjuvant drugs and indications for use for the various species are shown in the appended table.

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Jl S. Afr. vet. Ass. 44 (2): 185—186 1973

CASE REPORT GEVALVERSLAG

HEARTWATER IN THE ELAND

E. YOUNG* AND P. A. BASSON**

SUMMARY

Typical clinical signs and lesions found at necropsy, as well as the presence of the aetiological agent, *Cowdria ruminantium*, as observed in a three-month-old eland *(Taurotragus oryx)* calf, confirm that this species of antelope is susceptible to heartwater.

INTRODUCTION

Heartwater can maintain itself in nature in the complete absence of domestic ruminants[6]. It may cause an inapparent, transient reaction in some wild animals and be responsible for clinical disease and mortalities in others[1-7].

Controversial and rather vague reports from various sources with regard to the possible susceptibility of the eland, *Taurotragus oryx*, (Pallas, 1766) as well as rather indefinite results obtained after artificial infection of eland with heartwater-infected sheep blood, have now been supported by the confirmation of a spontaneous and classical case of heartwater in a three-months-old eland calf in the Addo National Park.

PRESENTATION

Clinical signs were the same as those seen in the domestic animal. Hyperaesthesia and circling with a stiff and unsteady, high-stepping gait were followed by prostration, opisthotonus, muscle tremors and convulsions, blinking of the eyes, prolapse of the membrana nictitans, continuous grinding of the teeth, and the discharge of froth from the nostrils and mouth. Clinical examination revealed pyrexia (body temperature exceeded 43°C), severe tachycardia (heart rate exceeded 400/m), and polypnoea (respiratory rate exceeded 60/m). The animal was not treated, and died about one hour after the onset of clinical disease.

Post-mortem examination revealed marked general congestion, hydrothorax, hydropericardium, subendocardial petechiae, pulmonary oedema, ascites, and splenomegaly. The clinical diagnosis of heartwater was confirmed by the demonstration of numerous characteristic colonies of *Cowdria ruminantium* in several stained preparations made from the hippocampus and other parts of the brain. These colonies were also seen in brain sections stained with haematoxylin and eosin. In addition, histopathological examination showed typical glial swelling and fine granularity of the glial cell cytoplasm as is seen in brain sections of domestic ruminants which have died from heartwater. Congestion, as well as mild, localized but fairly widespread vasculitis and oedema with rarefaction of the surrounding brain substance, was also observed. A few small haemorrhages and very small scattered foci of gliosis occurred around capillaries throughout the brain. There were localized areas of very mild lepto- and choriomeningitis and distinctly oedematous areas in the leptomeninx. Some of the vessel walls were also oedematous.

DISCUSSION

Besides affecting the eland, heartwater has also been found to be responsible for mortalities in other wild mammal species, i.e. springbuck *(Antidorcas marsupialis)*[5,7] and various exotic ungulates, including the Indian nilghai *(Boselaphus tragocamelus)*, fallow deer *(Dama dama)*, Barbary sheep *(Ammotragus lervia)* and Himalayan tahr *(Hemitragus jemlahicus)* (own observations and Smit, *personal communication)*. Springbuck[8] and eland (Grosskopf[1]; Neethling and Erasmus, *personal communication)* have already been immunized with heartwater-infected sheep blood. Further research, however, is required to facilitate successful immunization of animals of all susceptible species, prior to their release in heartwater infected regions.

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LETTER TO EDITOR — AAN DIE REDAKSIE

CAUTION IN THE TREATMENT OF CHEETAHS WITH MALATHION

Sir,

In a recent publication *(Jl S. Afr. vet. Ass.* 43(2): 205) the use of malathion in the treatment of *Notoedres cati* infested cheetahs was described. Wild carnivores are frequently treated with malathion-containing preparations which are generally considered safer than most other insecticides. Although no side-effects had previously been encountered in more than forty cheetahs and many other wild carnivores, treated with suspensions of the 5% *wettable powder* of malathion, a few cheetahs recently died after immobilizing them with phencyclidine hydrochloride (Sernylan, Parke-Davis) and bathing them in a 5% dilution of a commercially available *emulsified form* of malathion. Exceptionally good results had generally been obtained in mange-infested lions and cheetahs, treated with malathion but further research is obviously required to establish the safety of the various formulations of this and other parasiticides for wild animals, especially when used in conjunction with immobilizing agents. Until such data are obtained, it is recommended that a *2,5% suspension* of *malathion wettable powder* only be used for this purpose.

E. Young, T. Naude

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Toxicology Department, Onderstepoort.

BOOK NEWS — BOEKENUUS

VAKKUNDIGE EN TEGNIESE WOORDEBOEKE IN DIE LANDBOUBEDRYF

"Steinmetz" wat alreeds in die verlede verskeie vakkundige en tegniese woordeboeke in ses tale oor die landboubedryf gepubliseer het, het onlangs met drie nuwe publikasies voor die dag gekom, wat van besondere waarde vir wetenskaplikes kan wees:

1—'n Verbeterde uitgawe van die woordeboek oor veevoeding en veeteelt.
2—'n Woordeboek oor tuinbou en tuinboutegnieke en -implemente.
3—'n Woordeboek oor plaasimplemente en landboumasjienerie.

Dié woordeboeke wat in sakformaat uitgegee word en redelik goedkoop is (±DM 20,- elk), is in Duits, Engels, Frans, Spaans, Italiaans en Nederlands, en word met baie nuttige tekeninge geïllustreer.

Hulle is verkrygbaar van: H. Steinmetz, 524 Betzdorf/Sieg, Wes-Duitsland.

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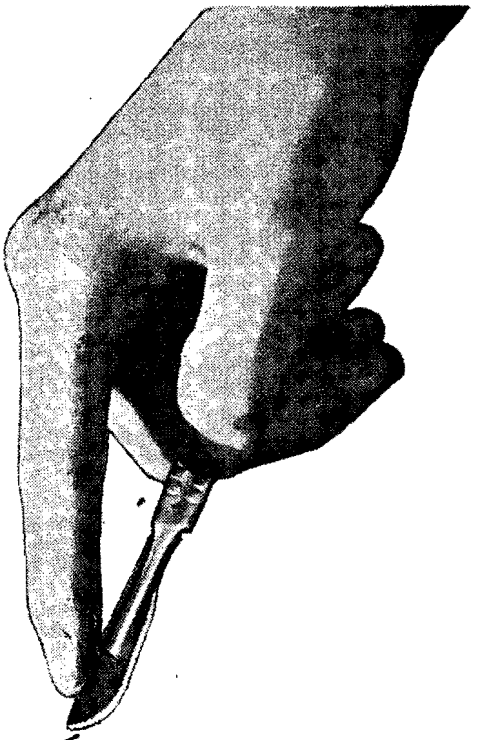
What's behind a precision sharp blade of persistent quality . . . . .

besides the surgeon's hand, that is?



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BOOK REVIEW BOEKRESENSIE

WRIGHT'S VETERINARY ANAESTHESIA & ANALGESIA

L. W. HALL

Baillière & Tindall. London. 1972. Pp 499. Price: £5,00.

The aims of the seventh edition of this book are wider than Professor J. G. Wright's and it contains much new material. Originally intended to provide the student with an introduction to the subject, and the practitioner with a practical guide, it now aims at "providing a comprehensive and stimulating introduction to veterinary anaesthesia for students" as well as remaining an up-to-date guide for the veterinarian in the field.

Of 483 pages nearly 100 have been rewritten or are entirely new, thus bringing the book as up-to-date as any text book can be. It is, of course, a "do-it-yourself" book that does not attempt to discuss in detail the physiology and pharmacology of anaesthesia. There is a paucity of illustrations for this type of book, making it difficult for the student or practictioner to attempt a new technique with confidence of success. It would have been better to produce the work in two volumes. Nevertheless, it is one of the best in the field, and is recommended as a text-book in the Veterinary Faculty of the University of Pretoria.

The additional pages on "General Considerations on Clinical Measurements" are welcome, but they neither go far enough nor are in sufficient detail. They serve purely to bring to the reader's attention the scope of the subject.

The chapter on pre-medication has been rewritten to include preparations which have come on to the general market within recent years. Products such as Etorphine, Fentanyl and Xylazine are mentioned briefly, as are some of the newer ataractics such as Azaperone; references are given. It is felt that this chapter could have been expanded with great profit.

The new introduction to the section on "Relaxation of the Skeletal Muscles during Anaesthesia" stimulates interest in the underlying phenomena. It is a very important field of growing importance to the veterinarian.

Also new is the chapter on "Artificial Ventilation of the Lungs", which summarizes this topic succinctly and clearly and the two pages on shock, which is an admirable effort in so small a space. Surely shock deserves a chapter on its own in a book on anaesthesia.

The chapter on "Accidents and Emergencies associated with Anaesthesia", which has largely been rewritten, is adequate for practical purposes.

As a new graduate I worked at Liverpool under Professor J. G. Wright and assisted in clinical trials and recording of results which the great teacher used in this innovating book. In those days much was known about the art of anaesthesia and little about the science. As I read this book, I was impressed with the progress which has been made since then. The pace is accelerating and this book will be out of date all too soon. At the moment it is the best in the field for students and practitioners. It has kept up the high standards set by Professor Wright. The paper, printing and binding are excellent. It can be recommended with confidence.

W. J. J.

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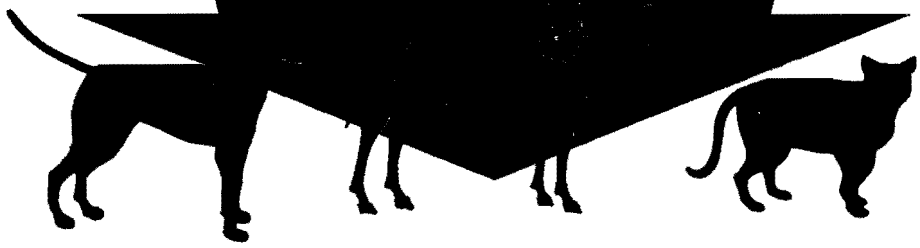
when inflammation strikes



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BOOK REVIEW — BOEKRESENSIE

HEALTH HAZARDS OF THE HUMAN ENVIRONMENT

World Health Organisation, Geneva 1972.

pp. 387, figs. 3; Tabs. 20; Publ. Price ?

This book is the result of the collaborative effort of 100 specialists from 15 countries. WHO has compiled this wide-ranging survey of environmental hazards to human health for the benefit of health authorities and others concerned with environmental problems. It represents a synoptic review of the highlights and contains numerous purposely condensed technical components relating to each field covered. To the veterinarian, who is inevitably concerned with environmental pollution and more particularly when he is actively engaged in public health, pharmacology, toxicology and food hygiene, this book represents a wealth of up-to-date views (some of which may still be controversial) and information. Because of the manner of presentation, it is most readily used as a reference book; the list of references at the end of each chapter provides the reader with the means to obtain greater detail and further information on particular topics.

The book is divided into four parts: The Community Environment; Chemical Contaminants and Physical Hazards; Surveillance and Monitoring and Public Health Practices; and Principles of Intervention. Chapters of particular interest to the veterinarian are those on air; water; food; soil; insects and rodents; the work environment; chemical pollutants; mutagens, carcinogens and teratogens; ionizing radiation; non-ionizing radiation and ultrasonic waves; communicable diseases; congenital malformations, chromosome aberrations and biochemical profiles; adverse reactions to drugs. A chapter on the potential advantage of the surveillance and monitoring of domestic and wild animals as a means of obtaining early warning of possible adverse environmental effects on man is of particular interest.

This book will undoubtedly find its place on the desk of all those who are interested in a topic which is of increasing importance to man and his environment.

L. W. v. d. H.

EQUIPMENT — UITRUSTING

INSECT-O-CUTOR

An organization very much concerned with hygiene has recently started to import Insect-O-Cutors for the control of flying pests and insects. This product and the range may be of interest to readers.

The product is a unique electrical insect control device which protects to a very high standard of hygiene and is designed for any concern involved in cleanliness. It eliminates flies, moths, mosquitoes, wasps and other flying insects. The attraction to the machine is by means of a short wave light lure and insects are killed instantly upon contact with an electrified grid and are then collected in a built-in tray. There is no chemical fall out, very little cleaning is required, and a continuous and automatic protection with negligible operational costs is provided. The machines require little space, give a very wide protection and are guaranteed for twelve months.

For details contact The South African Catering Organisation (Pty.) Ltd., P.O. Box 35244, Northcliff, Johannesburg.

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WHAT EVERY PROFESSIONAL PERSON SHOULD KNOW ABOUT INCOME TAX

DAVID SHRAND

Legal & Financial Publishing Co. (Pty) Ltd., Cape Town.

Feb., 1972, updated to Feb. 1973. Pp. 119. Price R2,50. Annual page replacement service R1,50.

The Income Tax Act includes many specific requirements with which the taxpayer must comply but every taxpayer is also entitled to organize his affairs so as to pay the least amount of tax. As a judge, in referring to tax avoidance, once remarked: "Taxpayers incur no legal penalties and strictly speaking no moral censure, if, having considered the lines drawn by the legislator for the imposition of taxes, they make it their business to work outside them." A taxpayer, therefore, is entitled to take advantage of any loophole offered in the Income Tax Act which will reduce or avoid his income tax liability. It is important, however, to appreciate the difference between tax avoidance, which is the minimization or avoidance of taxation by methods within the parameters of the law, and tax evasion, which is defrauding the Receiver of Revenue, and hence, a criminal offence.

A close study of "What every Professional Person should know about Income Tax" could be a rewarding experience, particularly to the self-employed veterinarian. Of particular interest is the chapter dealing with income tax as it affects the professional person. Much of what is allowable as a deductible expense by the Receiver of Revenue, is determined by current Departmental practice. For example Entertainment Expenses Allowed are 2½% of the gross fees in respect of medical practitioners and dentists and 5% of gross fees in respect of medical specialists, accountants, attorneys, etc. The allowance under this section is limited to R300.

It cannot be over-emphasized that deductible allowances are often determined as a result of individual negotiation with the Receiver of Revenue and a study of this publication will certainly indicate those areas where one is likely to meet with success. Mr. Shrand, for example, gives the allowance for wear and tear of furniture and fittings as 2½% to 5%, other authorities quote a figure of 10%.

Travelling allowances and living costs which are allowed in respect of post-graduate study courses are but some of the other items of interest.

The book is so designed that pages may be replaced; a replacement service is available for an annual subscription of R1,50, which provides up-dating following statutory amendments, case-law and Departmental rulings.

One error was noted. On page 34, under "Examples of Capital Receipts of Accruals" Item (6) reads: "Winnings from betting if the betting is engaged in as a profit-making scheme". This should of course read: "Winning from betting *unless* the betting is engaged in as a profit-making scheme". See also Page 18, Item (6), where this has been correctly stated.

D. K.

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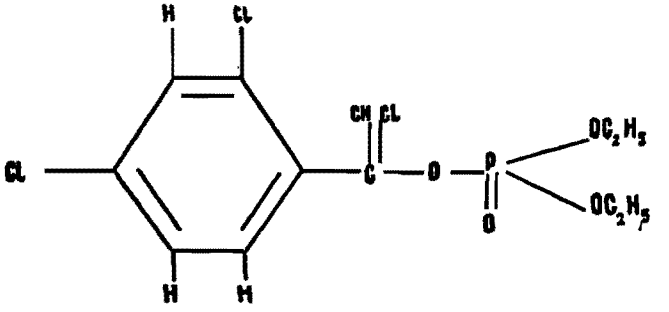

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THE BURROUGHS WELLCOME GROUP OF COMPANIES IN SOUTH AFRICA

On April 12, 1973, the new office, factory and warehouse in the Spartan industrial estate outside Kempton Park of the Burroughs Wellcome organisation in South Africa was offisially opened by Professor James Gear, regarded as much a friend and colleague in veterinary as in medical circles.

In his address Professor Gear mentioned that the firm of Burroughs Wellcome was established in England by Henry Wellcome, an American pharmacist and his fellow countryman, Silas M. Burroughs. Under the terms of Sir Henry Wellcome's will the entire share capital of the Wellcome Foundation with its associated concerns in England and abroad is vested in Trustees who are required to use the distributed profits for the advancement of research in human and animal diseases and related subjects anywhere in the world.

Burroughs Wellcome opened their first offices in Cape Town in 1902. This subsidiary, dealing with medical pharmaceuticals, has grown from the thirtieth largest pharmaceutical organization in 1962 to fourth place last year.

The firm of Cooper, a house-hold word in South Africa as far as sheep and cattle dips and insecticides are concerned and the largest veterinary company in the country for many years, also had its headquarters in the United Kingdom. It opened its first office in Port Elizabeth in 1893, although Cooper sheep dips had been in use in South Africa since the 1860's. It joined the Wellcome Foundation in 1959. It is not only the firm of Cooper that has personal ties with the veterinary profession in South Africa: Dr. J. H. Mason, for many years at Onderstepoort, came from the Wellcome Research Laboratoriese at Beckenham in Kent, before joining the staff of the South African Institute for Medical Research. Max Sterne, in turn, left Onderstepoort to join the Wellcome organisation in England.

A third British-owned, world-wide organiaztion, that of Calmic Ltd., handling products in the field of industrial hygiene, joined the Wellcome Foundation in 1966.

Under the general managership of Mr. Dieter Klingenschmidt, the three subsidiaries of the group in South Africa have pooled resources in respect of administrative and service functions at Spartan. From the R1,7 million plant here operations are controlled within the South and Central African zone, the Wellcome Foundation's fourth biggest market. Ninety percent of the goods that are sold by this joint organization are manufactured within the Republic of South Africa. Burroughs Wellcome and Calmic pharmaceuticals are manufactured on the site at Spartan. Under an agreement dating back for forty years, the Cooper products that are sold in South Africa are manufactured by African Explosives and Chemicals at Durban, and the warehouse at Spartan provides a distribution point for them.

In introducing Professor Gear to Mr. A. A. Gray, chairman of the Wellcome Foundation Ltd., London, and the guests present, Mr. Klingenschmidt stated *inter alia:* 'South Africa is fortunate in having some of the best and most workable laws for the control of medical and veterinary products. We fully support and endorse that legislation.'

The South African Veterinary Association extends its congratulations to the Wellcome Group of Companies upon reaching such an organisational and developmental milestone in South Africa and wishes it every success in its endeavours in the field of human and animal welfare.

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ONDERSTEPOORT ENTEROTOXAEMIA OIL ADJUVANT VACCINE

The Director of the Veterinary Research Institute, Onderstepoort, announces that in future the Onderstepoort enterotoxaemia vaccine will be issued as an oil emulsion.

This new vaccine is prepared from *Clostridium welchii* type D epsilon toxoid and is emulsified with oil which gives an exceptional adjuvant effect. With the old alum precipitated vaccine it was necessary to administer repeated injections in order to obtain a consistent immunity while a single injection of the oil adjuvant will give a high and enduring immunity.

It is recommended that lambs be immunized from 2 months of age by means of a single subcutaneous injection of 1,0 ml. Maximum protection is obtained after 6 weeks but a good immunity is already present within two weeks. The immunity persists for at least 12 months, whereafter a single annual inoculation will maintain the immunity at a high level.

The vaccine will be available in bottles containing 100 doses and full particulars regarding the handling of the vaccine are given in an accompanying pamphlet.

ONDERSTEPOORT BLOEDNIER OLIE-HULPMIDDEL-ENTSTOF

Die Direkteur van die Navorsingsinstituut vir Veeartsenykunde, Onderstepoort, maak hiermee bekend dat die Onderstepoortse Bloednier-entstof voortaan in die vorm van 'n olie-emulsie vrygestel sal word.

Hierdie nuwe entstof word berei van *Clostridium welchii* tipe-D-epsilon-toksoied wat met olie geëmulsifiseer is en wat 'n buitengewone uitwerking as hulpmiddel het. Terwyl dit met die ou aluin-gepresipiteerde entstof nodig was om herhaalde inspuitings te gee ten einde 'n konstante immuniteit te verkry, verleen 'n enkele inspuiting van die olie-hulpmiddel-entstof 'n hoë en langdurige beskerming.

Dit word aanbeveel dat lammers vanaf 2 maande ouderdom met 'n enkele onderhuidse inspuiting van 1,0 ml geïmmuniseer word. Maksimum beskerming word na 6 weke verkry maar 'n goeie immuniteit bestaan reeds na twee weke. Die immuniteit duur vir ten minste 12 maande en die daaropvolgende toediening van 'n enkele inspuiting per jaar sal die immuniteit op 'n hoë vlak hou.

Die entstof sal in bottels van 100 dosisse beskikbaar wees en volle besonderhede t.o.v. hantering van die entstof word in 'n bygaande pamflet uiteengesit.

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ONDERSTEPOORT VACCINES

A number of new vaccines will be released in due course. The following vaccines are still in the experimental stage and will only be available at a later date. Full particulars will be given at that time.

The vaccines concerned are:

(1) *Cl. chauvoei, Cl. oedematiens* and *Cl. sepcum* combined vaccine.
(2) *Vibrio fetus* vaccine.
(3) *Elephant-skin-disease* vaccine.
(4) *Three-day-stiffsickness* vaccine and
(5) *E. coli* vaccine for pigs.

The I.L.T. vaccine will only be issued to State Veterinarians.

There has also been an interruption in the issues of *C. ovis* vaccine but an improved product should be available again as soon as the final potency tests have been concluded.

As already announced in Parliament by the Minister of Agricultural Technical Services, a vaccine against Enzootic Abortion has been available from 1st April 1973.

The vaccine is prepared in eggs and consists of dead *Chlamydia* organisms in an oil emulsion. It conforms to the standards laid down in the British Veterinary Codex. The vaccine is intended exclusively for the immunization of sheep. It is not suitable for administration to cattle and other species because they do not exhibit a satisfactory immune response.

Sheep can be immunized at any age, but it is preferable to inoculate young ewes at least four weeks before the first mating season. The vaccine will not prevent abortions in pregnant or non-pregnant sheep which have become infected prior to immunization. Apart from abortions, the natural disease may also cause polyarthritis, pneumonitis, nervous symptoms and gastrointestinal disturbances in young lambs. Lambs may be immunized during the first week of age, but there is as yet no guarantee that the vaccine will protect against these manifestations.

Although a single administration of the vaccine will probably protect ewes against abortion for several years, a booster inoculation before the next breeding season may be advantageous.

ONDERSTEPOORT-ENTSTOWWE

Daar word beoog om in die afsienbare toekoms sekere nuwe entstowwe beskikbaar te stel.

Die volgende entstowwe is nog in die eksperimentele stadium en sal eers op 'n later datum vrygestel word wanneer volle besonderhede ook verstrek sal word. Hulle is:

(1) *Cl. chauvoei, Cl. oedematiens* en *Cl. septicum* gekombineerde entstof.
(2) *Vibrio-fetus*-entstof.
(3) Olifantsvelsiekte-entstof.
(4) Drie-dae-stywesiekte-entstof en
(5) *E. coli*-entstof vir varke.

Die I.L.T.-entstof sal slegs aan Staatsveeartse beskikbaar gestel word.

Daar was ook 'n onderbreking in die uitreiking van *C. ovis*-entstof maar 'n verbeterde produk behoort binnekort weer beskikbaar te wees sodra die finale immuniteitsproewe afgehandel is.

Soos reeds in die Volksraad deur die Minister van Landboutegniese Dienste afgekondig, is 'n entstof vanaf 1 April 1973 teen ensootiese aborsie beskikbaar.

Die entstof word in eiers berei en bestaan uit dooie *Chamydia*-organismes in 'n olieemulsie. Dit voldoen aan die standaarde soos in die British Veterinary Codex neergelê. Die entstof word uitsluitlik vir die immunisering van skape bedoel. Dit is nie geskik vir beeste of ander diersoorte nie, aangesien hulle nie op die entstof reageer nie en derhalwe geen immuniteit ontwikkel nie.

Skape kan op enige ouderdom ingespuit word, maar dit is wenslik om jong ooie ten minste 4 weke voor die eerste teelseisoen te immuniseer. Die entstof sal nie aborsies verhoed indien dragtige of nie-dragtige ooie voor inenting reeds besmet geraak het nie. Afgesien van aborsies kan die siekte ook aanleiding gee tot gewrigsontsteking, longontsteking, senusimptome and maagdermkanaalsteurnisse in jong lammers. Lammers kan gedurende die eerste week na geboorte met entstof ingespuit word maar daar is tot nog toe geen waarborg dat die entstof lammers teen hierdie vorms van die siekte sal beskerm nie.

Alhoewel 'n enkele toediening van die entstof ooie waarskynlik vir etlike jare sal beskerm, mag 'n skraag-inenting voor die volgende teelseisoen voordele inhou.

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INFORMATION INLIGTING

MIRACLE

MIRACLE, an acronym for Multidisciplinary Integrated Research Activities in Complex Laboratory Environments, is a project which represents almost a decade of of research and planning by a group of Purdue Natural Resources and Environmental scientists, headed by Dr R. L. Giese. It is a computer system designed to keep its sensors on the pulse of the environment.

The major mission of the MIRACLE project is to develop new research techniques, using the computer as a tool. Although the techniques are aimed at agricultural problems, they will also be of great value to scientists in other areas.

Data will be transmitted direct from the experiment source to the machine by means of various kinds of sensors. For instance, a sensor buried in the ground could measure the force of a raindrop and the path it takes and transmit a signal direct to the computer, rather than have an individual take a manual measurement, write down the data, return to the computer site, convert the data to numbers and punch it into the machine.

The sensors can be attached to growing plants to measure the amount of sunlight which falls on a leaf; to an animal to check out its environment: to a piece of meat to measure its toughness, all feeding information back into the computer's information banks.

Researchers will be setting up what is termed a Generalized Environmental Model (GEM) to feed MIRACLE. MIRACLE will be digesting mathematical versions of such environmental situations as solar and net radiation, soil temperature, atmospheric gases, pollen, remote sensing data, water information, soil moisture patterns, weather patterns, air temperatures, flooding histories, past yields, etc.

Once all this information is fed into MIRACLE's memory banks, and it will be a continual process since the computer will be literally plugged into the environment, the GEM will become a useful tool for research and extension. It will enable the scientists to issue agricultural advisories on such subjects as flooding, field traffic ability, irrigation, crop development, field yield forecasts, harvesting, fire probabilities, animal waste disposal and pesticide use.

The MIRACLE project's real objective is to gain maximum crop yields and reduce pesticide load in the environment, predicting where pest populations are and where controls are really needed.

(**Purdue Agricultural Reports.** Vol. 1, No. 4 (1972); Agricultural Experiment Station, Purdue University, Lafayette, Indiana. **Agricultural Report** No. 58. Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W. Washington, D.C. 20008, U.S.A. Published by Dept. Agricultural Technical Services, Pretoria).

INFORMATION INLIGTING

BABY PIG MORTALITY

It is estimated that 25 per cent of U.S. pigs die before they reach market weight. This figure had existed so long that it had become accepted as inevitable. Baby pig mortality has been reduced 17 percent by removing all piglets from the sow and feeding "Soweena" after the initial 24-hour colostrum feeding period.

In controlled studies at the Foremost Foods Company Research Farm, the small, weak piglets were removed from the sow and after a four week feeding period with a good pig milk replacer (Soweena) these piglets were as large and as vigorous as those which remained with the sow. The secret to success is management — and feeding an excellent sow milk replacer free-choice.

Clean habits, early colostrum, careful management and Soweena are a great deal less expensive than losing one pig in four.

(**The Professional Nutritionist.** Vol. 4, No. 3, (Oct-Dec. 1972) Foremost Feed Company, 850 Green Street, San Francisco, California 94133. **Agricultural Report,** No. 64. Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W. Washington, D.C. 20008, U.S.A. Published by the Dept. of Agricultural Technical Services, Pretoria).

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ELEKTRONEMIKROSKOPE — NUWE VERSKYNSEL

'n Ontdekking, wat die droom om basiese lewenstrukture op molekulêre vlak waar te neem 'n stap nader aan die werklikheid bring, is onlangs gedoen. Wetenskaplikes van die Lawrence Berkeleylaboratorium en die Universiteit van Kalifornië, ondersteun deur die Atoomkragkommissie, het in Frankryk dié belangrike bydrae tot die wetenskap gemaak en sodoende bestaande kennis, waarvolgens die gebruik van elektronemikroskope in die biologie beperk word, heeltemaal weerspreek. (Die wetenskap het tot dusver aanvaar dat, soos die energie van 'n elektronemiskroskoop styg, die mate van beskadiging van die biologiese monster wat ondersoek word, *stadig* afneem).

In lynregte teenstelling, bewys onlangse proewe dat, met die styging van die elektronemiskroskoop se straalenergie bo 1MeV, die beskadigingspeil *vinnig* afneem en kleiner strukture skerp uitgebeeld word. Geen verduideliking hiervoor kan egter in bestaande kennis gevind word nie. Die proewe is teen verskillende energiesterktes tot en met 2,5MeV uitgevoer en dui aan dat hierdie verskynsel, d.w.s. die dalende beskadigingspeil en beter gesigskerpte, heel moontlik ook teen sterktes van 5MeV en hoër geldig bly.

Indien 'n 5MeV elektronemikroskoop gebruik sou kon word, is die verwagting dat 'n akkurate molekulêre beeld van die DNA- en RNA-kettings uiteindelik verkry sou kon word, wat regstreeks ontleding van dié belangrike genetiese kode moontlik sou maak.

Om die werk te kan voortsit, word 'n 3—5 MeV elektronemikroskoop vereis, en die V.S.A. beskik nie oor soiets nie. Vir die proewe wat die twee Amerikaners in Toulouse (Frankryk) uitgevoer het, is 'n 3MeV elektronemikroskoop (die sterkste wat tans beskikbaar is) gebruik. Japan beskik oor 'n soortgelyke instrument maar nêrens ter wêreld is 'n sterker instrument tans beskikbaar nie.

(**BioScience.** Vol. 22, nr. 11, November 1972. **Landbourapport** Nr. 50, Landbouraad (Wetenskaplik). Ambassade van Suid-Afrika, Massachusettslaan 3051, N.W. Washington, D.C. 20008, V.S.A. Uitgegee deur die Dept. Landboutegniese Dienste, Pretoria).

DIE SOEKLIG VAL OP *NUWE* EUROPESE BEESRASSE

Die *nuwe* Europese teelstapel (NETS), d.w.s. die sogenaamde *eksotiese beesrasse*, is voortreflik wat grootte en ook melkverskaffing betref. Massatoename van jongossies is ook goed, maar kalfverliese (Tabel 1) en die onvermoë om, onder voeromstandighede in die V.S.A., die Keurgraadstempel te behaal, is twee groot nadele wat in oorweging geneem behoort te word.

Volgens die Assistent-direkteur, Afdeling Veekunde van die VSDL se Landbounavorsingsdiens, sal beesvleisproduksie en -teelt in die V.S.A. binne die volgende tien jaar 'n meer gespesialiseerde en noukeurige reeks van ondernemings wees as wat tans die geval is. Dit is sy mening dat beeste spesifiek geteel (of „na bestelling geteel") sal word om die doeltreffendste onder spesifieke omgewings- en bestuursomstandighede op te tree, t.w. verskillende rasse en soorte vir verskillende omstandighede, en dat produksiedoeltreffendheid met bemarkingsvereistes vir spesifieke karkassoorte in verband gebring sal word.

In 'n artikel met die opskrif „Design for Beef Cows" wat in die blad „The Progressive Farmer" van Januarie 1971 verskyn het, is 'n lys van eienskappe wat alle doeltreffende vleiskoeie behoort te besit, aangegee. Op daardie basis kan 'n algemene indruk van hoe die gemiddelde nuwe Europese teelstapel optree, van die volgende afgelei word:—

1. *'n Kalf elke 12 maande:* Die NETS tree gewoonlik swak op. Vir elke jaar wat 'n koei oorslaan beteken dit 'n 14% verlies in haar potensiële leeftydsproduktiwiteit. Kommersiële boere kan nie bekostig om 15% tot 25% van hul koeie met kalwing te help nie. Groot verliese t.o.v. dooie kalwers en/of koeie, d.w.s. volgroeide koeie — in kuddes waar NETS-vaars gebruik is, is reeds waargeneem.

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Alhoewel min data beskikbaar is, kan afgelei word dat die vrugbaarheidsvlak van NETS laer is as dié van Hereford-Angus en Jersey gekruistes. (Tabel 2).

2. *Lae Voervereiste:* Vergeleke met V.S.-rasse vereis die NETS meer voer, a.g.v. meer koeimassa.

3. *Afkalwingsgemak:* Gekruistes van NETS-bulle en Angus- en Herefordkoeie tree in hierdie opsig swak op.
4. *Melkverskaffing:* Uitstekend — oor die algemeen hoër as dié van V.S.-rasse.

5. *Maklike Hantering:* Goed. NETS is gewoonlik mak.

6. *Langlewend:* Redelik. In Europa is die beeste langlewend. Hoe hulle egter onder V.S. plaas- en weidingomstandighede en omgewingsomstandighede sal optree is nog onbekend.

7. *Groter speenmassa:* Goed, veral gekruiste NETS. (Tabel 3).

Boere word egter aangeraai om eers oor positiewe inligting te beskik dat 'n verandering in teeltstapel 'n groter hoeveelheid bemarkbare beesvleis teen goeie pryse sal meebring, voordat enige teeltprogramveranderings aangebring word. Verskille in omgewingomstandighede tussen dié van 'n boer en dié waaronder data versamel is, kan die data geheel en al weerspreek.

(**The Progressive Farmer.** Desember 1972. **Landbourapport Nr. 63.** Landbouraad (Wetenskaplik), Ambassade van Suid-Afrika, Massachusettslaan 3051, N.W. Washington, D.C. 20008, V.S.A. Uitgegee deur die Dept. Landboutegniese Dienste, Pretoria).

Table 1: CALVING DIFFICULTY — HEREFORD AND ANGUS COWS — 1970 CALF CROP* (USDA, MARC)

Breed of Sire	Percent of two-year-old cows requiring assistance	Percent of three-, four-, and-five-year-old cows requiring assistance	Percent of calves born dead or dying shortly thereafter†
Hereford	50	8	2.7
Angus	46	3	3.2
Jersey	19	1.5	1.5
South Devon	65	15	3
Limousin	80	18	6
Simmental	70	24	11
Charolais	77	25	10

*1971 data not yet released.
†Three-, four-, and five-year-old cows.

Table 2: HEREFORD-ANGUS MATURE COWS — 1970 (USDA, MARC)

Breed of Sire	Percent of calves born alive	200-day adjusted weaning weight	Weaning weight produced per cow calving*	Steer slaughter weight produced per cow calving†
Hereford × Angus	97	462	451	1,024
Angus × Hereford	96	461	445	1,013
Jersey	98	448	440	966
South Devon	96	474	457	1,042
Limousin	94	486	457	1,015
Simmental	89	497	445	1,008
Charolais	90	502	452	1,021

*Pounds produced per cow calving (obtained by multiplying 200-day adjusted weaning weight by calving percent).
†Pounds produced per cow calving (obtained by multiplying steer slaughter weight by calving percent).

Table 3: POSTWEANING GROWTH AND FERTILITY OF CROSSBRED HEIFERS — 1970 (USDA, MARC)

Breed of Sire	Adjusted 550-day weight	Percent pregnant*
Hereford (Hereford heifers)	650	67
Angus (Angus heifers)	683	80
Hereford (Angus heifers)	737	96
Angus (Hereford heifers)	704	87
Jersey	661	91
South Devon	730	73
Limousin	730	78
Simmental	753	81
Charolais	771	77

*Sixteen months of age; 71-day breeding program; 45 days AI, 26 days cleanup bulls.

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BROILERS AFFECTED BY PARENTAL LIGHT TREATMENT

Performance and profitability of broilers is markedly affected by light conditions under which parental birds lay eggs for hatching.

Parental birds reared under increasing day length (similar to normal light in spring), demonstrated the following compared with other treatments listed below.

1. Reached 50% egg production at a very early age.
2. Hatching eggs were small and continued small throughout laying period.
3. Mortality was higher in broilers that hatched, particularly during the first week.
4. Body weights of broilers that hatched were lower, reducing monetary returns.

Parental Day Length Treatments:

1. 14-hour constant day length.
2. Day length beginning at 17 hours/day the first week then reduced 25 minutes/week (from the evening end of the day only) to a 9-hour day at 20 weeks then increased 25 minutes-week until a 14-hour day was reached.
3. The same as Number 2, except that during the growing period, day length was shortened from both ends of the day on alternate weeks.
4. Day length of 9 hours and 15 minutes the first week increased 15 minutes/week (on the evening end of the day) so that a 14-hour day length was reached at 20 weeks of age and a 14-hour day length continued thereafter. This treatment is similar to that encountered by birds reared under natural day length when hatched around the middle of December.

Hatching eggs were collected from the parental flock when the flock was 180 to 190 days of age. These eggs were incubated and hatched to evaluate the performance of broilers hatched from parents which had been maintained under the four different light treatments.

The parental day length treatment No. 2 revealed a consistently lower progeny mortality from 7 to 56 days of age than the 14 hour constant daylight treatment. Treatment No. 4 resulted in a 2 to 4-fold increase in progeny mortality over Treatment No. 1.

Feed conversion and monetary return of the broiler, due to parental light treatment, was also favoured by Treatment No. 2.

(**Canadex**, Agriculture Canada, (1972); Ottawa, Canada. **Agricultural Report** No. 64, Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W. Washington, D.C. 20008, U.S.A. Published by the Dept. of Agricultural Technical Services, Pretoria).

AIRBORNE TRANSMISSION OF AN AVIAN TUMOUR VIRUS

The chief reason the chicken suffers the highest mortality from lymphoid tumours of any species of animal is infection with Marek's disease virus which is of the same family as the "cold sore virus". This disease virus matures in the skin of infected chickens and is released into the air.

The form the virus takes as an airborne agent has been studied for 4 years by Dr T. N. Fredrickson, Department of Pathobiology and R. P. Prince, Department of Agricultural Engineering. They have established that the virus can travel through the air within cells which are sloughed from the skin and, also, within inclusion bodies from infected cells, or as individual viral particles. The virus can stay alive in dust for many months without losing infectivity. However, decay is hastened by heat.

This research effort has significance not only in attempts to reduce the spread of disease among chickens but also to study basic forms of airborne transmission of viral diseases. Although this virus does not affect man, it can be used as a model to study induction of similar neoplastic conditions seen in humans. Thus, the research is also directed toward study on the comparative pathology of human cancer.

(**Milestones.** Vol. 16, No. 1 (Fall-Winter 1972-73); Connecticut Agricultural Extension Service, University of Connecticut, Storrs, Connecticut 06268. **Agricultural Report** No. 64, Agricultural Counsellor (Scientific), Embassy of South Africa, 3051 Massachusetts Ave., N.W. Washington, D.C. 20008, U.S.A. Published by the Dept. of Agriculture Technical Services, Pretoria).

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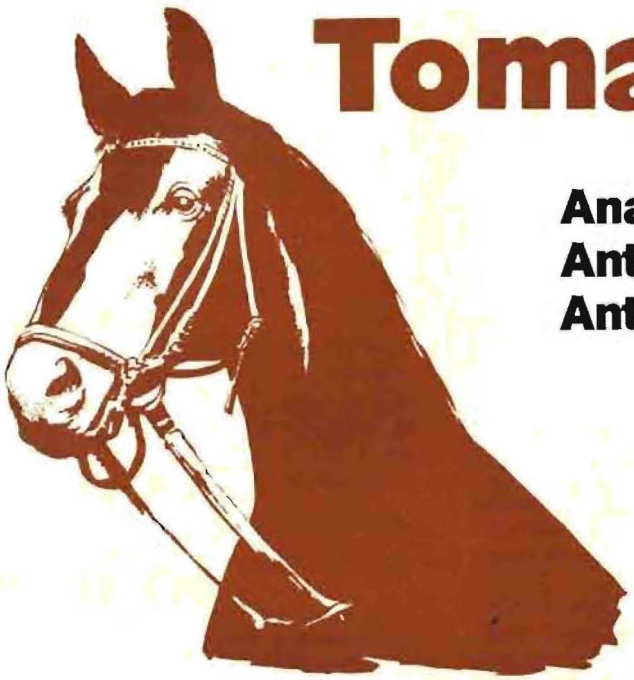

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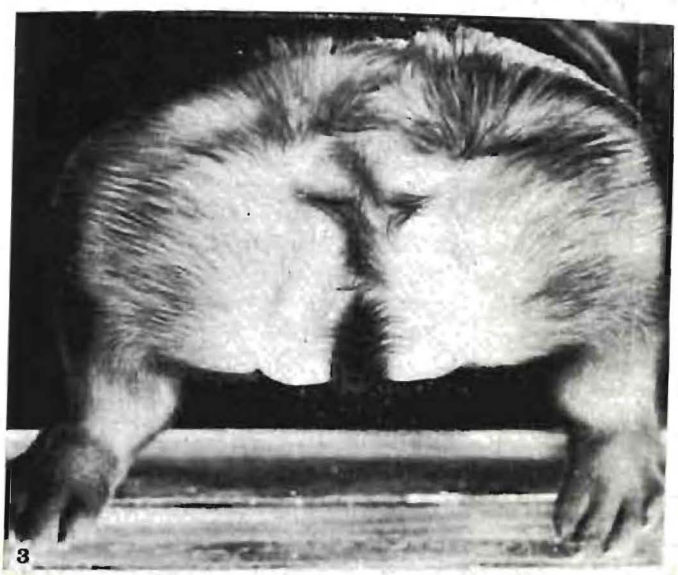

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Akardiese gedrogte
Acardic monstrosities

see overleaf
sien keersy

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TREFFERBLAD

AKARDIESE GEDROGTE IN DIE ONDERSTEPOORT-VERSAMELING

Akardiese gedrogte is wel-erkende, alhoewel betreklik seldsame, gedrogte. Isidore, seun van die beroemde Franse vergelykende anatoom, Etienne Geoffrey Saint-Hilaire, het hulle reeds beskrywe en as „omfalosiete" bestempel.

Die algemeen aanvaarde konsep aangaande genese is dat die akardiese gedrog die abnormale maat van 'n normale identiese tweeling is. Vroeë optrede van uitgebreide vaskulêre anastomose tussen die twee individue en die toevallige (?) ontwikkelingsfisiologiese oorhand van die een oor die ander sou dan 'n bloedvloeiommekeer in die mindere lid teweeg bring, met gevolglike atrofie, of, meer waarskynlik, ingrypende ontwikkelingsremming. Uiterste remming en/of atrofie verwek dan 'n **acardiacus amorphus (mola cruenta)** soos gesien in fig. 1, beskrywe deur Curson (1932, 18th Rep. Div. vet. Servs Anim. Indust. Onderstepoort. bldss. 1077-8. Dit was as tweeling van 'n normale stamboek-Frieskalf gebore.

Van soortgelyke aard is die akardiese gedrog („kefalidiese gedrog" volgens Lesbre — 1927. Traité de Tératologie, Parys: Vigot Fréres), waaraan 'n miniatuur mond en tong herkenbaar is (Fig. 2). Hierdie monster, deur dr J. van Staden van die firma Roetskor (Edms.) Bpk., verkry, was een van 'n vers-tweeling uit 'n veronderstelde opreggeteelde Bruin-Switserse moer van 'n Staatsgenomineerde Fries vaar. Hierdie feit verminder die moontlike oorerwingsinvloed.

Aan die koplose tipes in fig. 3 (hondjie) en fig. 4 (lam) is geen geskiedenis verbonde nie.

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Fotografie: A. M. du Bruyn, Onderstepoort.

FEATURE PAGE

ACARDIAC MONSTROSITIES IN THE ONDERSTEPOORT COLLECTION

Acardiac monstrosities are well recognized, although relatively rare, abnormalities. Isidore, son of the famous French comparative anatomist, Etienne Geoffrey Saint-Hilaire, had already described and named them 'omphalosites'.

The generally held concept regarding their genesis is that the acardiac monstrosity is the abnormal partner of a normal identical twin. Early establishment of extensive vascular anastomosis between the two individuals, and the fortuituous (?) developmental and physiological ascendency of the one over the other member, would cause reversal of blood flow in the lesser member with consequent atrophy, or, more likely, extensive developmental arrest. An extreme degree of arrest and/or atrophy would produce an **acardiacus amorphus** (mola cruenta) as seen in figure 1, described by Curson (1932, 18th Rep. Dir. vet. Servs Anim. Indust. Onderstepoort. pp 1077-8). It was born as a twin to a normal pedigree Friesian calf.

Of similar nature is the acardiac monstrosity ("cephalidian monstrosity" according to Lesbre — 1927. Traité de Tératologie. Paris: Vigot Fréres) of which a miniature mouth and tongue are discernable (Fig. 2). This specimen, obtained by Dr J. van Staden from Messrs Roetskor (Pty) Ltd., was one of a female twin bred from a supposedly pedigree Brown Swiss dam and a State nominated Fries sire. This fact would diminish the possibility of hereditary influence.

The acephalic types depicted in figure 3 (pup) and figure 4 (lamb) have no detailed history.

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Photography: A. M. du Bruyn, Onderstepoort.

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