The Main Block.

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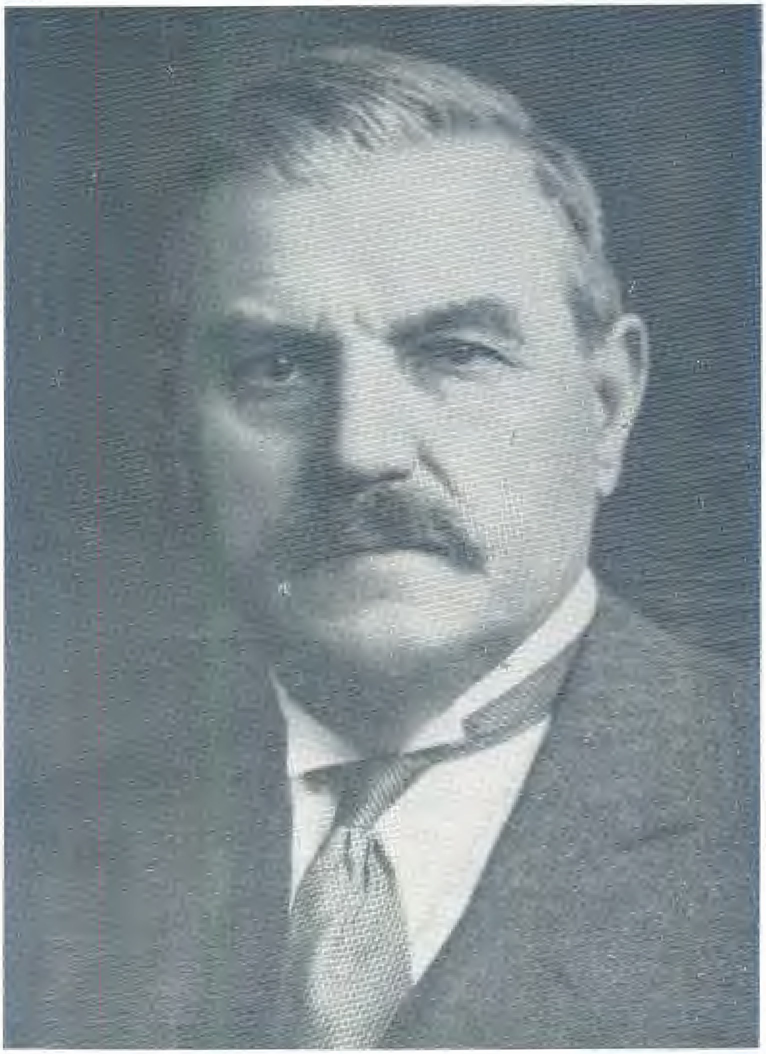
THE ONDERSTEPOORT VETERINARY RESEARCH LABORATORY 1908–1958

INTRODUCTION

On 13 October, 1958, the Onderstepoort Veterinary Research Laboratory celebrated the 50th Aniversary of its existence as a Veterinary Research Institute at its present site some six-and-a-half miles due North of Church Square, Pretoria.

The main feature of the celebrations was an informal gathering of leading personalities in agriculture in the Union, together with representatives of the South African Agricultural Union and its affiliated provincial associations and other recognised agricultural organizations. This representative gathering was given a brief résumé of the organization of the Division of Veterinary Services as a Division of the Department of Agriculture together with an outline of the activities of its two subdivisions: Field Services on the one hand, and on the other the Onderstepoort Laboratory which is responsible for research, diagnosis, vaccine production, the dissemination of information and, until recently, higher veterinary education. Thereafter two full days were spent in visiting the various laboratories where the responsible officers explained to small groups in rotation, in general terms, the work that was proceeding, suitable exhibits having been erected as a visual aid to clarify the written notes which were distributed.

Received for publication on 12 October, 1960.—Editor.



Sir Arnold Theiler, K.C.M.G., Dr. Med. Vet. (Berne), D.V.Sc. (S.A.), Ph.D. (Berne), D.Sc. (Syracuse), D.Sc. (Cape), Hon. Assoc. R.C.V.S.
Born, 1867—Died, 1936.
Director, 1908 to 1927.
Dean, 1920 to 1927.

Finally the visitors assembled in the main auditorium under the Chairmanship of Mr. J. G. Grobler, President of the South African Agricultural Union, in the presence of the Honourable, the Minister of Agriculture, Mr. P. M. K. le Roux, for a discussion of what had been seen. From the frank exchange of opinions conducted in the friendliest atmosphere without any restriction or inhibition two main points emerged:—

(1) Amazement at the volume and diversity of the research and routine work being carried out in the interests of the live stock industry of the country.

(2) A feeling of disappointment, amounting almost to frustration, that those who benefited most from the work were aware neither of what had been achieved in the past nor the progress of current investigations.

The direct result has been that the provision of a more efficient and flexible extension service, within the resources of the Department, is receiving attention but in addition the staff of Onderstepoort decided to compile a record of the work of the Institute during the first fifty years of its existence to highlight the achievements, the disappointments and the failures.

This proved to be no mean task but the undertaking has been honoured by the presentation of this publication as a supplement to the *Onderstepoort Journal of Veterinary Research.* In the 27 volumes of that journal will be found, in strictly technical form, the results of completed research. In this supplement there appears in semi-popular style, a style which it is hoped will prove interesting to the layman as well as to the scientific browser, a résumé of the efforts of Onderstepoort to fulfil its function as the guardian of the health of the domestic animals of the country for maximum production and reproduction.

In conclusion I would be guilty of a serious omission if I did not make use of this opportunity to express my sincere thanks to those members of the staff who compiled the data in each specialised field upon which this article is based. To name them all would be invidious but in particular I wish to mention Professor R. Clark, Head of the Department of Physiology of the Faculty of Veterinary Science, who was responsible for moulding that data into its final form.

R. A. ALEXANDER,
Director of Veterinary Services.

THE EARLY HISTORY OF VETERINARY SCIENCE IN SOUTH AFRICA.

Before describing the foundation of Onderstepoort and its growth over the last 50 years, it is only fitting that we should pay tribute to the early pioneers of Veterinary Science in South Africa.

Hutcheon, who was Chief Veterinary Surgeon to the government of the Cape Colony from 1880 to 1900, when he became Director of Agriculture, was called the "Nestor of Veterinary Science in South Africa" by Theiler. Although not a laboratory worker, he made valuable observations in the field and many of his conclusions were subsequently proved correct by scientific experiments. On his death the farmers for whom he had worked raised a fund which today awards an annual prize—known as the "Duncan Hutcheon Prize"—to a student of the faculty of veterinary science. Another early Cape worker who made valuable contributions was Lounsbury, who held the post of Government Entomologist. He demonstrated the transmission of heartwater by the bont tick (*Amblyomma hebraeum*) in 1900 and of East Coast fever by the brown tick (*Rhipicephalus appendiculatus*) in 1903. In 1892 the Colonial Bacteriological Institute was founded in Grahamstown with Edington as officer-in-charge. In 1906 the laboratory was transferred to the Cape Veterinary Department. Edington was later succeeded by Robertson. The diseases investigated at this laboratory included horsesickness, rinderpest, redwater and heartwater. Edington was one of the first to show that heartwater could be transmitted by inoculation with infected blood.

The early history of veterinary science in Natal will always be associated with the name of Watkins Pitchford, who was appointed Principal Veterinary Officer to the Natal government in 1887. In 1898 the Allerton Veterinary Laboratory was built just outside Pietermaritzburg, primarily for work on rinderpest which was then sweeping the country. After the epizootic, Allerton became a diagnostic and vaccine production laboratory producing anthrax and blackquarter vaccines and lymph for smallpox vaccination. Later, antiserum against various snake venoms was also produced there. Pitchford's most valuable contribution was probably his work on combating ticks by means of dipping tanks and arsenical dip washes. Reputedly the first cattle dipping tank built in South Africa was erected at Allerton. Despite the advent of synthetic insecticides and spray races, the dipping tank and arsenical wash still remain the foundation of tick control.

In Rhodesia, Koch investigated East Coast fever—then known as Rhodesian redwater—as early as 1903. Bevan also did valuable pioneer work in the early part of this century.

In 1891 a young Swiss veterinarian by the name of Arnold Theiler, arrived in the South African Republic. After a two-year struggle for recognition he obtained his first opportunity in 1893, when smallpox broke out in the mining town of Johannesburg. Theiler had had experience in preparing smallpox calf lymph and was entrusted with this duty by the authorities, an assignment which he performed with complete success. He was then appointed consulting veterinarian to the Rand Health Board and one of his first duties was to draft legislation dealing with glanders.

Early in 1896 news of a devastating cattle disease approaching from the north was received in Pretoria and Theiler was summoned by President Kruger and sent to Rhodesia to investigate the report. During the next two years Theiler fought an heroic battle against a devastating epizootic of rinderpest which swept through the country. Robert Koch, working at Kimberley, showed that bile from animals dying of the disease was a valuable immunizing agent. Subsequently Kolbe and Turner, and Theiler in collaboration with Danysz and Bordet, did valuable pioneer work on the active and passive immunization of cattle against rinderpest by the use of immune serum.

THE RIGHT HON. GENERAL LOUIS BOTHA, P.C., *Minister of Agriculture.*
DR. ARNOLD THEILER, C.M.G., *Government Veterinary Bacteriologist.*
F. B. SMITH, ESQ., *Director of Agriculture.*

The catastrophic losses caused by rinderpest convinced the government of the Republic of the urgent need for veterinary research and of Theiler's capabilities, but just at this juncture the Anglo-Boer war broke out and Theiler joined the Transvaal commandos.

After the war the occupying British authorities appointed Theiler " Veterinary Bacteriologist " to the Transvaal and he was given a small laboratory, consisting of wood and iron shanties, at Daspoort near Pretoria. He continued in this appointment when the Transvaal was granted " Responsible Government " under the premiership of General Louis Botha.

Despite very inadequate facilities, Theiler produced an enormous amount of research work from the Daspoort laboratory. So impressed were the authorities that they voted £80,000 (a very large sum in those days) for the erection of a new veterinary research laboratory. Theiler selected a site on the farm " Onderstepoort " some seven miles north of Pretoria—reputedly because it was the worst area for horsesickness in the district—for the new institute and the building was occupied in 1908.

It says much for the foresight of Louis Botha and his colleagues and for the personal reputation of Theiler, that such a progressive step could be taken only seven years after the conclusion of a tragic and devastating war.

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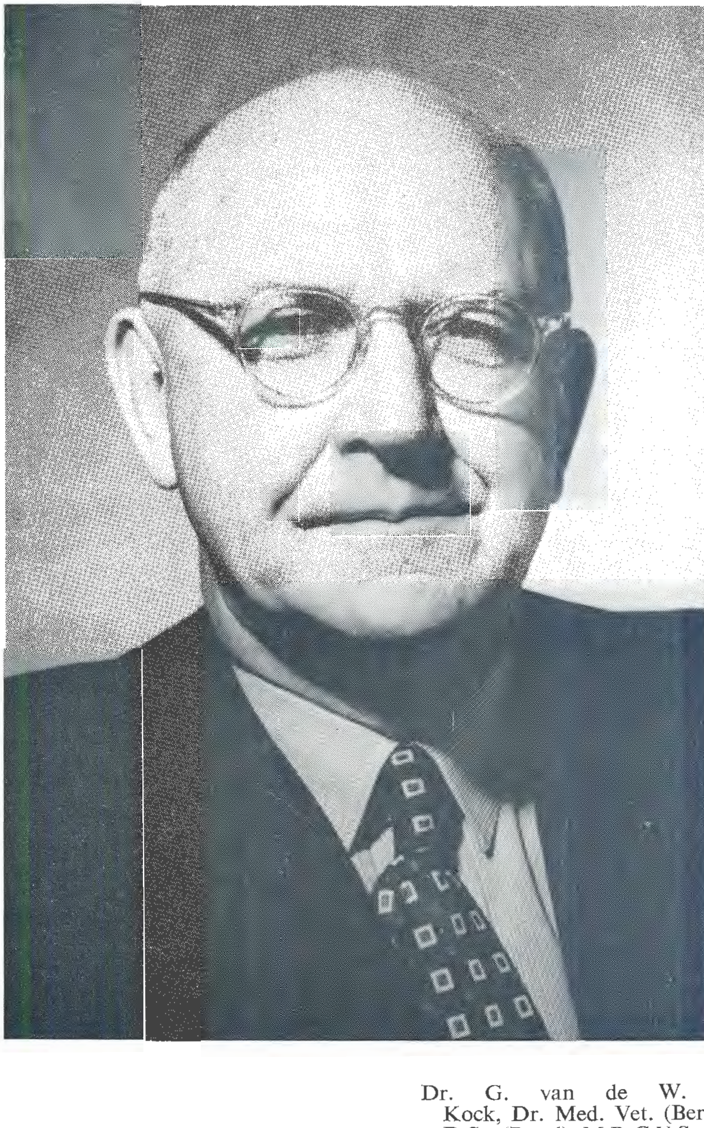
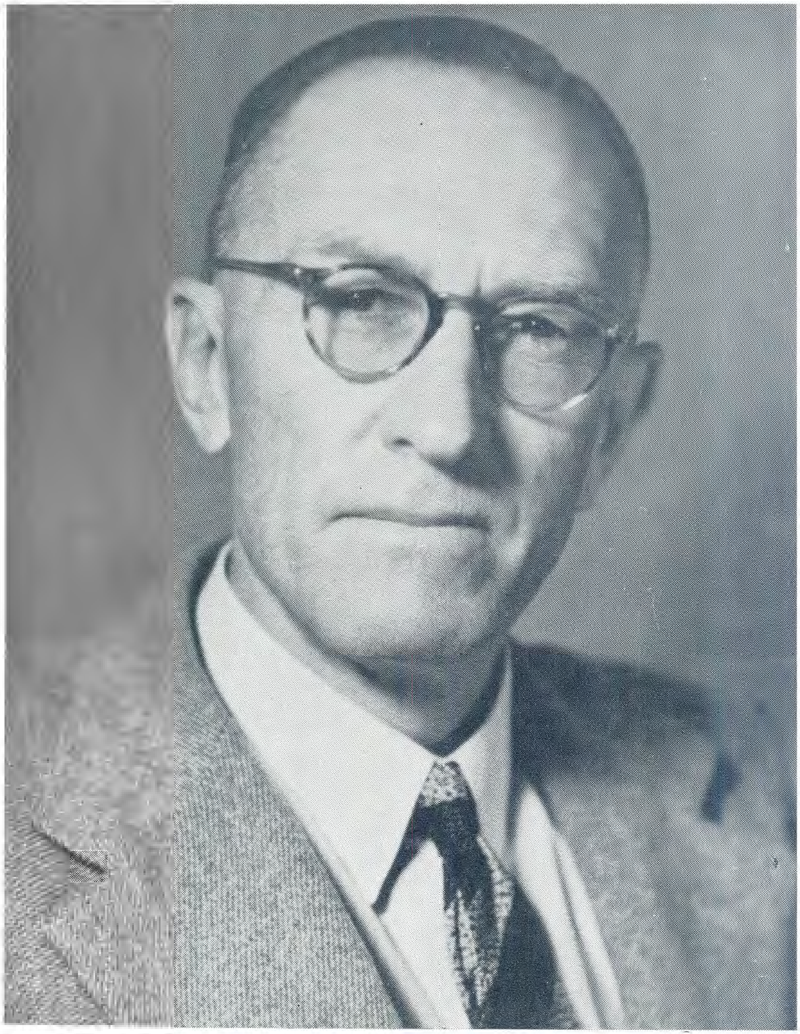
Dr. P. J. du Toit, B.A. (Cape), D.Phil. (Zurich), Dr. Med. Vet. (Berlin and Utrecht), D.Sc. Agric. (Stellenbosch), D.Sc. (Cape Town and Witwatersrand), L.L.D. (Glasgow and Rhodes), Hon. Assoc. R.C.V.S., F.R.S. (London).
Director and Dean from 1927 to 1948.



Dr. G. van de W. de Kock, Dr. Med. Vet. (Berne), D.Sc. (Rand), M.R.C.V.S. Director and Dean from 1948 to 1949.



Dr. J. I. Quin, D.V.Sc. (S.A.).
Director and Dean from 1949 to 1950.

Onderstepoort Today

As described in the previous chapter, Onderstepoort was founded in 1908 under the Transvaal government. In 1910 the four provinces, i.e. Transvaal, Natal, the Cape Province and the Orange Free State, united to form the Union of South Africa and Onderstepoort became the headquarters of veterinary research for the whole country, falling under the control of the Union Department of Agriculture. From 1910 to 1927 veterinary research was divorced from veterinary field services, the latter forming a separate division of the department. In 1927 the two divisions were merged under one head who held the title " Director of Veterinary Services ".

Onderstepoort is and always has been a government institute financed by Parliament through the Department of Agriculture and operating under the financial control of the Treasury. This implies that all revenue and unexpended funds are credited annually to the Consolidated Revenue Fund. In 1908 the total cost of the buildings at Onderstepoort was £80,000 and the technical staff consisted of five veterinarians and five laboratory assistants. By 1958 the value of the buildings had increased to over one-and-a-half million pounds and the staff is now as follows:—

Directorate

Director
Dr. R. A. Alexander

Deputy Director
Dr. H. Graf

Dr. R. A. Alexander, B.Sc. Agric. (S.A.), D.V.Sc. (Pretoria), D.Sc. (H.C.) (Cape Town). Director from 1950.

The Laboratory at Daspoort before 1908.

Sub-Directors
Dr. R. M. du Toit
Dr. J. G. Louw
Dr. J. H. R. Bisschop

Chief Administrative Officer
Mr. F. Coetsee

Total professional staff—66, of which 38 are veterinarians

Technicians	88
Clerical staff	52
Others	569
TOTAL	775

(The organisation of Onderstepoort is given at the conclusion of this chapter.)

In 1908 the annual expenditure was £34,000 and the revenue earned £8,500. In 1958 the corresponding figures were £674,500 and £462,500, respectively. Revenue earned is derived mainly from the sale of vaccines and from the collection of nominal fees for diagnostic services.

To-day Onderstepoort is a huge institute comprising numerous buildings and occupying over 500 acres of ground. Adjacent to the laboratory site itself is a farm of over 6,800 acres, which is an integral part of the institute.

The expansion of Onderstepoort has taken place steadily during the fifty years of its existence and parallels the general development of the country as a whole and the stock breeding industry in particular.

The main functions of the institute may be listed as follows:—

(*a*) *Research into all aspects of veterinary science*

A short résumé of the most important research work carried out over the last 50 years is given in the following chapters.

(*b*) *Vaccine production*

It has always been the policy of the department to manufacture and issue all veterinary vaccines required by the country; in fact, the production of veterinary biologicals by private enterprise in the Union is prohibited by law.

(*c*) *Diagnostic services*

Onderstepoort maintains a large-scale diagnostic service embracing all types of examinations which are either done free of charge or for a nominal fee.

(*d*) *Advisory services*

Although it is the policy that stock owners should seek advice from state veterinarians in the field or from private practitioners, numerous farmers still appeal direct to Onderstepoort when in trouble. By force of circumstances in the past, the South African farmer was frequently his own veterinary adviser. In many instances the description of the disease which accompanies an order for vaccine indicates that the owner has made a wrong diagnosis. A special officer handles dozens of letters, telephone calls and personal interviews daily, giving advice on all manner of veterinary problems. It is the present policy to establish Regional Investigational Centres situated at strategic points to deal with the problems associated with the maintenance of animal health with a minimum of delay.

(*e*) *Regulatory duties*

In South Africa no stock remedy may be offered for sale without prior registration under the Fertilizers, Farm Feeds, Seeds and Remedies Act, 1947 (Act No. 36 of 1947). Professional officers at Onderstepoort act as technical advisers to the Registrar appointed under this Act.

(*f*) *Veterinary education*

Although the Faculty of Veterinary Science is a Faculty of the University of Pretoria, all the staff are Union Civil Servants and the nucleus of full-time lecturing staff is supported by members of the Onderstepoort staff on a part-time basis. The Faculty is, therefore, an integral part of the atmosphere and spirit of Onderstepoort.

(The Faculty of Veterinary Science is fully described in the following chapter.)

All these functions are so interwoven that they cannot be described separately.

The reader will now be taken on a tour of Onderstepoort and will visit some of the sections.

The Main Building at Onderstepoort, 1908.

On entering the main gates one passes along a tree-lined avenue flanked by staff houses set in attractive gardens. At the end of this avenue is the " Main Building " (erected in 1908), in front of which stands the granite statue of Sir Arnold Theiler, carved by the South African sculptor, Coert Steynberg. Beneath this statue of the founder of Onderstepoort lie the ashes of both Sir Arnold and Lady Theiler.

In the " Main Building " are the offices of the Director and Deputy Director and the Sections of Parasitology and Protozoology.

Behind the main building is the old quadrangle, flanked by horse stables. This was the scene of great activity every morning in the old days, with dozens of horses standing at the hitching rails and the " Old Man " (Sir Arnold) in characteristic wide-brimmed hat and apron inspecting the animals in his experiments on horse-sickness. Today, the white mouse having replaced the horse as the producer of horse-sickness vaccine, the old " quad " is somewhat deserted.

Section of Anatomy

Head: Professor H. P. A. de Boom

Staff: Professional Assistant: 1

This is a full-time faculty department and teaching is its main function.

Research is carried out into the identification of hairs from various wild and domestic species. Hair identification has an interesting background. Dried venison, or biltong as it is called, is much sought after in South Africa and demands a very good price. Unfortunately many people exploit this market, which involves wholesale destruction of game. The South African laws relating to game preservation are exceedingly rigid and the sale of biltong made from game is prohibited. When a " biltong hunter " is caught with his wares he invariably maintains that the biltong is made from beef, which is, of course, permitted. The onus is then upon the Crown to prove otherwise. It was found that animal hairs could invariably be found on the biltong or containers and that these could be identified microscopically with certainty. This service has brought many a poacher to justice.

The Department of Anatomy is also interested in malformation in animals and especially in hereditary defects of economic importance.

SECTION OF BACTERIOLOGY

Head: Dr. B. C. Jansen

Staff: Professional Officers... 5
Technicians........... 12

This section is responsible for the preparation of seven different bacterial vaccines. More detailed descriptions of the development and present techniques used in the production of some of these vaccines will be found under the chapters on the diseases concerned, but a short description will be given here.

Anthrax vaccine (8 to 9 million doses per year). The vaccine consists of the spores of non-capsulated avirulent variants of the anthrax bacillus grown on a solid medium and suspended in glycerine saline, as the vehicle. The technique of developing avirulent variants from virulent strains was developed in this laboratory.

Lamb Dysentery vaccine and *Exterotoxaemia* vaccine. These are both formol toxoids of *Clostridium welchii* types B and D, respectively, prepared by standard methods. The annual output of these vaccines is: Lamb Dysentery vaccine—400,000 doses and Enterotoxaemia—10 million doses.

Calf Paratyphoid vaccine (375,000 doses per year). Cultures of *Salmonella dublin* are grown in cellophane bags suspended in a corn steep liquor medium and aerated during growth. The vaccine consists of a formalin killed alum-precipitated bacterial suspension.

Blackquarter vaccine (over 2 million doses per year). The vaccine consists of a formalinised meat-liver-broth culture of *Clostridium chauvoei.*

Botulism (*Lamsiekte*) vaccine (3 million doses per year). Cultures of *Clostridium botulinum* Types C and D are grown separately in cellophane bags suspended in a corn steep liquor medium. The vaccine consists of a formol toxoid adsorbed on to aluminium phosphate.

Brucellosis (*Contagious Abortion*) vaccine (500,000 doses per year). As described elsewhere, this vaccine is produced by the use of the *Brucella* vortex aerated liquid culture technique using Strain 19 *Brucella abortus.* This vaccine is issued in freeze-dried form.

In addition to the above vaccines over 150,000 doses of tuberculin are produced annually. Three types are prepared, viz. bovine and human P.P.D. and avian tuberculin.

Some 700 doses of mallein (for testing horses for glanders) are also produced.

Research work designed to improve the quality and production methods of these vaccines is continually in progress.

SECTION OF BIOCHEMISTRY

Head: Dr. J. G. Louw

Staff: Professional Officers....... 15
Technicians.............. 6

One of the main routine functions of this section is the control of animal feeds offered for sale to the public. In South Africa no compounded stock feeds may be sold prior to registration under Act No. 36 of 1947. Inspectors are empowered to take samples of any feed offered for sale and some 150 such samples are received at Onderstepoort annually. These are analysed and the results checked with the registered composition of the feed.

Samples of fish meal are regularly analysed for nutrient constituents and trace elements, and the biological value of the protein content is determined. Many of these fish meals are taken from bulk supplies intended for export and the quality is rigidly controlled.

Other routine duties include the analysis of feeds from various sources, the control of the rations used in the government pig-testing stations and the biological determination of the value of phosphatic compounds intended for use as feed supplements.

The section is at present conducting a nationwide survey of trace elements in natural grazing plants. Some 6,000 specimens have been collected. Analyses are done by spectrographic and flame photometric techniques.

Other matters being investigated are the influence of Vitamin A and phosphate on cellulose digestion in ruminants, the stability of " stabilized " Vitamin A products and the diagnosis of cobalt deficiency in sheep by determination of the Vitamin B_{12} level of the blood.

The section is also investigating microbiological and cellular nutritional requirements and growth in collaboration with the sections of bacteriology, virology and tissue culture.

Section of Bionomics

Head: Prof. J. H. R. Bisschop

The indigenous cattle of South Africa were slow in growth and poor in production when compared with the improved breeds of Europe. With the industrial expansion that occurred during the last half of the nineteenth century, large-scale importations of exotic breeding stock took place. It was found that the first crosses between imported bulls and indigenous females were markedly superior to the indigenous dams but that top crosses failed to maintain this improvement. In fact, pure-bred and high grade exotic animals appeared to show a gradual retrogression from one generation to the next.

The discovery of a marked phosphorus deficiency in many parts of South Africa (which has been described elsewhere) suggested a possible explanation for this degeneration, and a long-term experiment was started at Armoedsvlakte in 1925. Some 300 nondescript indigenous cows and heifers were divided into four herds and graded up with pure-bred Afrikaner, Friesland, Red Poll and Sussex bulls, respectively. This was continued until 1958, i.e. for a period of 33 years.

For the first 13 years each group was subdivided into a " bone meal supplemented " and a " control " subgroup. The beneficial effects of supplementation with phosphates were amply demonstrated, but it was found that the exotic breeds showed retrogression after the first crossing despite such supplementation. On the other hand, the Afrikaners showed no deterioration. Phosphorus deficiency was, therefore, not the sole cause of the regression observed in the exotic breeds.

From 1938 to 1958 a broad bionomic investigation into the reactions of succesive generations of these herds to the environment has been made. During this period phosphate deficiency was excluded by adequate supplementation. The data collected include climatological records, nutritional data, weight gains, body measurements and full breeding records. In addition, blood analyses have been conducted regularly. Each batch of steers was slaughtered under controlled conditions and full records were kept.

The colossal task of analysing and correlating the data collected is now in progress.

Section of Dips and Dipping Control

Head: Mr. P. M. Bekker

Staff: Professional Officers....... 5
Technicians.............. 2

This section is responsible for the control of all preparations used in the campaign against external parasites of domestic animals. These products must also be registered by the manufacturers before they are offered for sale and include preparations containing arsenic, DDT, BHC, and the new organic phosphorus insecticides. All such dips must be tested and controlled as regards chemical composition, stability, efficacy and safety. The staff advises the Registrar appointed under the Act of all registrations.

Research work includes the development of new techniques for testing the never-ending stream of new insecticides evolved by commercial enterprise.

Section of Medicine

Head: Prof. K. van der Walt

Staff: Professional officers....... 2
Technicians.............. 3

This is a full-time faculty department mainly devoted to teaching, but research is carried out in many aspects of clinical medicine. A full study of the clinical pathology of biliary fever in dogs (Babesiosis) is being conducted as well as investigations into the practical aspects of blood transfusion in cattle with reference to shock and group sensitivity.

The following animals were treated in the clinics during the year 1957–58.

	Hospitalized	*Out patients*
Cattle.........................	147	167
Horses and mules...............	44	53
Sheep and goats................	22	53
Dogs and cats..................	1,025	1,146

This gives a grand total of 2,677 animals treated.

Section of Microbiology

Head: Dr. F. M. Gilchrist (Senior Research Fellow, Stock Diseases Research Fund)

Staff: Professional Officers....... 4
Technicians.............. 4

This section is organised in collaboration with the Council for Scientific and Industrial Research for the purpose of research into ruminal microbiology. The main lines of investigation at present are—

(i) a study of the functional metabolic groups of bacteria in the rumen and the effect of different diets on the dynamic balance of such groups;

(ii) the cultivation and counting of cellulytic bacteria in the rumen and a study of their nutritional requirements;

(iii) investigations into bloat, with special reference to the cause of frothing of the ingesta;

(iv) conditions influencing the conversion of urea nitrogen to protein by ruminal organisms.

SECTION OF PARASITOLOGY

Head: Dr. R. M. du Toit

Staff: Professional Officers....... 5
Technicians.............. 2

This section deals with all arthropod and helminthic parasites of domestic animals. These parasites constitute a major problem in South Africa. Ticks and tick-borne diseases have played havoc among almost all species of stock in the past. With the advent of more and more intensive farming, worm parasites are increasing in density. The position is also complicated by the presence of numerous species of wild mammals, many of which act as hosts to parasites affecting domestic stock. A classical example of such a relationship is the tsetse fly, which really depends on game for its existence but transmits trypanosomiasis to domestic animals. The story of the struggle against some of the major insect-borne diseases will be told later.

The routine duties of the section include the identification of all endo- and ectoparasites.

Parasites of wild fauna have received considerable attention and over 150 hitherto unknown species of helminths as well as numerous arthropod parasites from such animals, have been described.

The Minister for Agricultural Technical Services, Mr. P. M. K. le Roux, addressing the gathering at the celebration of the 50th Anniversary of the founding of Onderstepoort in 1958.

In the past the main emphasis in the control of internal parasites has been on the application of curative treatment. It is now realized that this method of attack alone will not succeed and that more must be learned of the biology of the parasites. Furthermore, the conditions under which infestation occurs vary widely from the hot humid subtropical Natal coast to the highveld grasslands and the semi-arid Karoo. For this reason a survey covering the main ecological areas of the Union is being conducted. This survey includes the seasonal incidence of the various species of internal parasites of cattle, sheep and Angora goats, together with a study of their ecology and the efficacy of various remedies.

Likewise, it is realized that the battle against ticks will not be won by the dipping tank and spray race alone. For many years a survey of the occurrence of the various species of ticks in the Union and in many other parts of Africa has been conducted at Onderstepoort. Maps showing their distribution and spread in relation to climatic and other conditions have been prepared. In this way a vast amount of knowledge of the biological requirements of the various species is being collected.

Before leaving the section of parasitology we visit the insectarium, which was recently completed at a cost of £15,000. This building is equipped to allow for the maintenance of any desired temperature and humidity in different rooms which are used for the breeding of various insects. In the hot, humid laboratories we see cages buzzing with blowflies. In another room an assistant is working on the previous night's catch of insects collected from " light traps ". Tiny midges (culicoides) are sucked into an aspirator and transferred to gauze cages where they are kept for further study.

Section of Pathology

Head: Dr. J. D. Smit

Staff:	Professional Officers.......	3
	Technicians..............	6

This section is responsible for all routine and research work in the field of pathological anatomy, both macroscopic and microscopic.

There are two post-mortem halls where all animals dying on the station as well as carcasses brought in for examination, are autopsied. In 1958 some 350 such post-mortem examinations were performed.

The section receives about 2,000 specimens a year for histopathological examination. These include specimens sent in by veterinarians and farmers as well as those from other sections of Onderstepoort. In all, nearly 20,000 histological slides are prepared and examined annually.

Subjects receiving special attention at the moment include the histopathology of the sex organs in relation to sterility and venereal diseases, epidural abscessation in cattle, goitre and the pathology of diseases caused by poisonous plants.

One of the demonstrations given at the anniversary celebrations.

The Museum

The Onderstepoort museum is housed in the Pathology Block although the exhibits are not confined to pathological specimens. The large hall is divided into bays in which all aspects of veterinary science are depicted by means of charts, photographs and preserved specimens. Opposite the entrance is a bust of Sir Arnold Theiler, below which his decorations and medals are displayed. Of particular interest is a group of beautifully executed wax models of poisonous plants which were made at Onderstepoort. The museum is a great centre of attraction to visitors.

SECTION OF PHYSIOLOGY

Head: Prof. R. Clark

Staff:	Professional Staff.........	2
	Technicians..............	2

This is a full-time faculty department.

The section collaborates with the Section of Microbiology in the study of digestion and metabolism in ruminant animals. The effects of drugs which have a physiological action are also investigated.

One of the section's main activities at the time of writing is the investigation into " Geeldikkop ", a hepatogenous photosensitivity of sheep thought to be caused by a plant, *Tribulus terrestris*. This study has involved basic research into bile pigment metabolism and liver function in the sheep.

The section is also responsible for the routine testing of mares for pregnancy where the Ascheim–Zondek test is employed.

Some 150 samples are tested annually.

SECTION OF PHOTOGRAPHY

Head: Mr. A. M. du Bruyn
Staff: Technicians.... 2

This section is equipped to carry out all photographic work for the institute, including microphotography and cinematography.

SECTION OF PROTOZOOLOGY

Head: Dr. W. O. Neitz

Staff:	Professional Officers.......	3
	Technicians..............	3

As this section deals largely with tick-borne diseases, a large number of animals is maintained under tick-free conditions. For this purpose stables and exercising yards have been built entirely surrounded by a furrow which is kept filled with a tick-destroying fluid. All personnel entering the premises have to put on protective clothing and gum boots, and all bedding and fodder are steam-sterilized before use. Some 120 cattle are kept and bred in this " tick-free " stable. The rearing of calves under such artificial conditions has presented many problems. The steam-sterilization of the hay and bedding not only kills all ticks but also all the normal bacterial flora. It also leeches out many of the mineral salts. These difficulties have been overcome largely by the use of antibiotics to control diarrhoea in the young calves and by the feeding of a balanced mineral supplement.

Three Directors of Onderstepoort together: Sir Arnold Theiler, Dr. P. J. du Toit and Dr. G. van de W. de Kock. The photograph was taken during Sir Arnold's visit to Onderstepoort in 1936, shortly before his death.

The Veterinary Research Institute

1. Tuberculosis stable; 2. Sheep pens; 3. Farm yard; 4. Incinerator; 5. Small animal breeding plant; 6. Nutrition research stables; 7. Pig plant; 8. Poultry plant; 9. Paddocks for horses and cattle; 10. East Coast fever stable; 11. Meat research laboratory; 12. Cultivated area; 13. Paddocks and stables for experimental animals; 14. House for available small experimental animals; 15. Transport stable; 16. Sheep stables; 17. Smithy; 18. Feed barns and silos; 19. Isolation stables; 20. Dog kennels and pig sties; 21. Gynaecology and artificial insemination; 22. Pathology; 23. Workshops; 24. Yard office; 25. Mice breeding house; 26. Blood-group research; 27. Caretakers house; 28. Bacterial and virus diseases; 29. Vaccine dispatch; 30. Fire station and water-tower; 31. Bacterial diseases; 32. Chemistry and biochemistry; 33. Stables; 34. Lumpy skin disease isolation stable; 35. Tick-free isolation stables; 36. Library and assembly hall; 37. Administration offices; 38. Main building; 39. Worm remedy production; 40. Stores; 41. Virus diseases; 42. Cafe; 43. Post office; 44. Typistes; 45. Statue Sir Arnold Theiler; 46. Accounts and purchases; 47. Insectary; 48. Power station; 49. Tennis courts; 50. Park; 51. Director's residence; 52. Residence; 53. Railway siding.

An aerial view of Onderstepoort taken in 1936. The main building can be seen in the right hand mid-foreground and the library on the left foreground.

This section prepares two vaccines: one against Anaplasmosis (Gallsickness) and the other against Babesiosis (Redwater). Both these vaccines consist of the blood of animals infected with the parasites concerned and some 40 such reservoirs are maintained. In the case of anaplasmosis, the parasite used is *A. centrale*, which produces a mild reaction but immunizes against the more virulent field type, *A. marginale*. There are two types of redwater in South Africa, the one caused by *Babesia bigemina* and the other by *Babesia bovis* (locally called " European Redwater "). These two species are maintained in separate reservoirs and the blood is pooled to form a bivalent vaccine.

Other routine duties performed by the section are the testing of horse serum samples for dourine by the complement fixation test, the examination of specimens for coccidiosis and the consultative examination of blood smears for the identification of protozoal parasites. Such smears are received not only from the Union but from many other countries. Large amounts of animal blood and serum are also supplied to medical and biological laboratories throughout the country.

As much of the research work undertaken by the section necessitates the experimental transmission of dangerous diseases by ticks, e.g. East Coast fever, a second special stable has been erected. This stable has been so constructed and organised as to obviate any possibility of infected ticks escaping or being carried away. Here ticks are hatched out in special rooms where the temperature and humidity are controlled and they are fed artificially on host animals. Altogether some 19 head of cattle, 10 sheep and numerous small laboratory animals are housed in the tick-proof stable.

One of the main lines of research at the moment is the transmission and chemotherapy of the various protozoal diseases, including the different types of East Coast fever and related conditions.

Another disease receiving considerable attention is " Elephant Skin Disease " of cattle (Besnoitiosis, formerly known as Globidiosis), which is of considerable economic importance in the bushveld areas.

Section of Poultry Pathology

Head: Dr. J. D. W. A. Coles

Staff: Professional Officers...... 2
Technicians.............. 2

The systematic study of poultry pathology started at Onderstepoort in 1931 with the formation of a special section for the purpose. Prior to that date the study of avian diseases had been only sporadic, yet valuable contributions had been made: check lists of the endo- and ectoparasites of poultry and wild birds had been compiled; the ostrich, which was of great economic importance in the early days, had received some attention; aspergillosis was proved to be responsible for heavy mortality in chicks and the ostrich was found to be susceptible to botulism (type D). Botulism (type C) was also found to be responsible for mortality among ducks and turkeys.

Since its inception, the Poultry Section has been responsible for running a large scale poultry plant of some 4,000 birds which supplies not less than 1,000 eggs a day for use in the various laboratories of the Institute. Notable progress has been made over the last 22 years in developing in a closed flock, a strain of Leghorns characterized

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by high egg production, freedom from communicable diseases such as fowl typhoid, B.W.D. and C.R.D., low mortality and relative freedom from all types of cancer. The hen house average is now 200,000 eggs per year. Total losses up to the age of 600 days from neurolymphomatosis and all types of tumours have dropped from just on 50 per cent in 1936 to 4 to 5 per cent in 1958.

Aegyptianellosis in fowls, ducks and geese has been studied and the vector proved to be *Argas persicus*. This tampan was also shown to be responsible for an acute toxic paralysis seen in ducks and geese, frequently mistaken for botulism.

The first diagnosis of psittacosis in pigeons and in Gouldian finches imported from Australia, was made at Onderstepoort.

Recently Chronic Respiratory Disease and Infectious Sinusitis have assumed grave economic importance and methods of eradication, including the use of blood tests, have been evolved. The results to date have been most gratifying.

The section also maintains a large scale diagnostic and advisory service to farmers. Over 3,000 consignments of birds for post-mortem examination are received annually. The officers of the section also advise on the formulation of poultry rations registered under the relevant Act.

Section of Reproductive Disorders and Artificial Insemination

Head: Dr. J. S. van Heerden

Staff: One Research Fellow (Stock Diseases Research Fund)
Professional Officers....... 2
Technicians.............. 3

This section deals with all reproductive disorders, the production, storage and distribution of disease-free viable semen and the practice of artificial insemination.

Some of the main diseases receiving attention are vibriosis in cattle and brucellosis in sheep. The latter condition has proved to be a major cause of infertility.

The section is also responsible for the training of inseminators who are then eligible for registration under the provisions of the Artificial Insemination Act. From 40 to 50 persons are so trained annually.

Attached to the section is an officer of the Division of Animal Husbandry who is working on blood groups in cattle. Application of this work enables the parentage of stud animals to be proved beyond doubt.

Section of Surgery

Head: Professor C. F. B. Hofmeyr

Staff: Professional Staff......... 2
Technicians.............. 3

This is a full-time faculty department mainly devoted to teaching. The equipme includes well-appointed operating theatres and X-ray facilities.

Another portion of the Faculty buildings.

The animals treated in the year 1957–1958 consisted of—

Cattle....................	194
Horses and mules.........	221
Sheep and goats...........	66
Pigs.....................	25
Dogs and cats............	968
TOTAL...............	1,474

Research is carried out on operative techniques and the section collaborates with other sections where experimental surgery is required.

SECTION OF TOXICOLOGY

Head: Dr. T. F. Adelaar

Staff:	Professional Officer.......	1
	Technicians..............	2

South Africa possesses one of the most varied flora of any country in the world and, unfortunately, also a very wide range of poisonous plants, many of which are peculiar to the sub-continent. Theiler and his contemporaries described many conditions due to plant poisoning and identified the various species responsible. The work was carried on by Dr. D. G. Steyn who published a long series of articles on the poisonous plants of South Africa. Many problems still remain and research continues.

The section is also responsible for the investigation of all mortality suspected of being due to poisoning, and some 2,000 specimens are examined annually.

Section of Virology

Head: Dr. R. A. Alexander

Staff: Professional Officers...... 4

Technicians.............. 13

The section of virology is one of the largest and most rapidly expanding sections of Onderstepoort. This is due to two factors: firstly, the tremendous variety and great economic importance of viral diseases in Africa, and secondly, the fact that virology is one of the youngest and most vigorous branches of medical science the world over.

Viruses are too small to be seen even under the most powerful optical microscopes and they cannot be grown on nutrient media as can bacteria; they will only develop in the presence of living cells. Some twenty-five years ago, to say that a disease was caused by an ultravisable virus indicated that that was the sum total of our knowledge of the causal agent. Today viruses can be cultivated, measured and even photographed. They can be specifically identified and their concentration measured.

Prior to 1931 there was no special section of virology at Onderstepoort. In that year, however, Alexander adapted the virus of horsesickness to propagation in the brains of mice by the technique developed by Max Theiler in the laboratories of the Rockefeller Foundation, New York, in his work on yellow fever. This led to the production of the first attenuated virus vaccine against horsesickness. It is intriguing to note that the son of Sir Arnold Theiler, though working in another land, helped to lay the foundation for such great advances at Onderstepoort.

The next great advance in virology was the introduction of the technique of growing viruses in the developing chick embryo, by Woodruff and Goodpasture in 1931. As stated previously, viruses will only multiply in the presence of living cells. The embryo presented just such cells in a sterile container—truly a " living test tube ". The technique was quickly taken up at Onderstepoort and developed for application to the study of many local viruses, including bluetongue, distemper, Rift Valley fever, lumpy skin disease and the rickettsias.

Inoculating eggs in the virus section.

It has long been known that certain animal cells can be removed from the body and propagated on artificial media. As long ago as 1913 it was revealed that viruses could be grown on such tissue cultures, but it was not until 1925 that any real progress was reported. The adaptation of the method in 1949 to the propagation of polio virus gave a great impetus to this technique and today it has become standard practice at Onderstepoort and other virus laboratories.

The changes brought about by the different viruses in the growing cells have been closely studied at Onderstepoort. This method frequently allows of an early identification of the virus and is of great interest in the study of its effects on the living cell.

Vaccine production.

The virus section prepares eight different types of vaccine.* Of these, five are produced from eggs, viz. (annual production given in parentheses) bluetongue (22,500,000), distemper (24,000), rabies (47,000), fowl pox (4,000,000) and Newcastle disease (192,000). For this work over 1,000 eggs per week are used. When it is remembered that each egg must be incubated, candled, injected, reincubated (often at a special temperature) and then harvested, the scope of the work can be realized.

The remaining three vaccines, horsesickness (151,000) and the combined Rift Valley fever and Wesselsbron disease vaccine (168,000), are made from mice and 45,000 of these animals are used annually.

In addition, some 28,000 doses of heartwater infected blood are issued annually.

All the above vaccines are rigorously tested for potency and safety before issue.

* Details of the techniques employed are given elsewhere.

Freeze drying

The section of virology issues all vaccines in freeze-dried form and 16 centrifugal freeze-drying machines are employed. In addition to the viral vaccines, a large proportion of the contagious abortion vaccine is also freeze-dried by this unit. The total number of doses of vaccine handled annually amounts to over 27 million.

Diagnosis

The section is responsible for diagnostic tests on all specimens connected with suspected viral infections. This includes routine biological testing for rabies, the identification and immunological classification of the viruses of horsesickness, bluetongue, lumpy skin disease and many others. The service is not confined to material forwarded from the Union, but periodically deals with specimens received from the entire African Continent as well as from other parts of the world.

Some of the freeze-drying machines.

Sterilization, using a large steam autoclave.

Research

The research work being conducted at present is mainly in regard to the following problems, viz:—

(i) *Lumpy skin disease.*—Every effort is being made to produce a prophylactic vaccine based upon the development of attenuated strains of the viruses which cause the disease.

(ii) *Heartwater.*—The propagation of the heartwater rickettsia in ferrets, mice, embryonated eggs and in tissue culture, again with the ultimate hope of producing a vaccine.

(iii) *Bluetongue.*—The study of the distribution of immunological types of virus in the country with a view to improving the immunological spectrum of the vaccine.

(iv) *Horsesickness.*—The investigation of the immunogenicity of the vaccine strains and the classification of new strains.

THE SMALL ANIMAL PLANT

Officer-in-Charge: Dr. N. Reinach

Staff: Technicians.............. 2

Labourers................ 34

The ready availability of small animals at Onderstepoort is the envy of many visiting scientists. The laboratory animal breeding plant is extensive and well-organised and, thanks to our South African climate, many of the animals can be kept partially out-of-doors. The following table gives an idea of the scope of the plant.

Species	Average stock kept	Annual Issue
White mice	50,000	240,000
Guinea-pigs	6,500	17,000
Rabbits	460	1,300
White rats	140	1,100
Hamsters	120	420
Ferrets	250	320

All green feed for these animals is produced on the station. In addition, 21 tons of a balanced feed and 6 tons of lucerne hay are used monthly, as well as milk, eggs and meat for the ferrets.

A corner of the small animal plant.

The Yard

Officer-in-Charge: Dr. G. D. Sutton

Staff: Technicians	1
Foremen	4
Labourers	74

The staff of the " yard " is responsible for the feeding and maintenance of all animals on the station including first aid attention, sanitation and hygiene. The average numbers of animals kept during the year are—

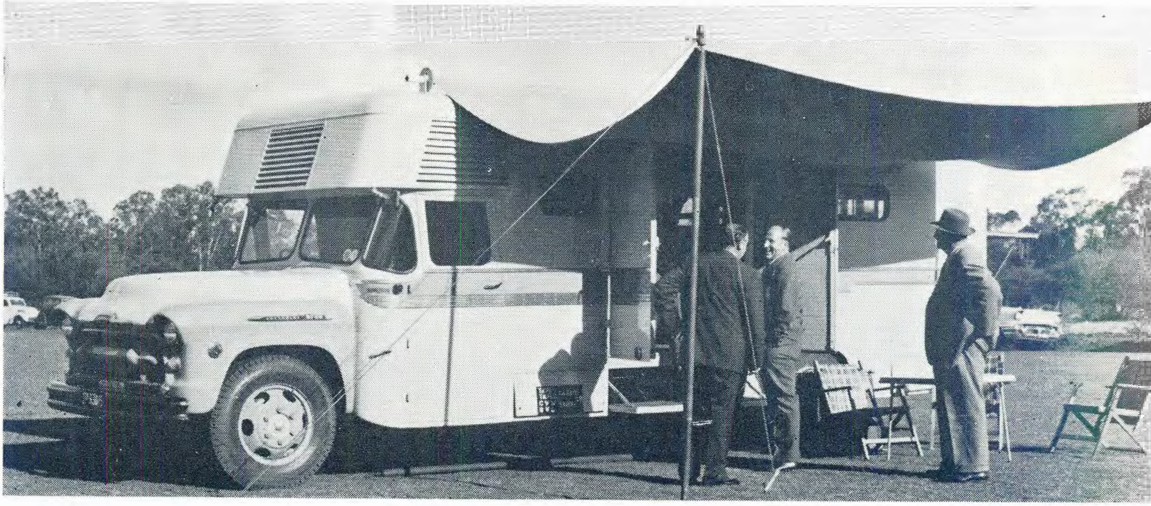
Cattle	500
Horses	60
Mules	40
Donkeys	12
Sheep	1,800
Goats	100
Pigs	80

Buildings include the necessary feed sheds, Dutch barns and silos, as well as races, dipping tanks and a shearing shed.

There is also a fully-equipped blacksmith's shop and harness maker's rooms.

The farm " Kaalplaas " adjoins the laboratory grounds and is used for the breeding of experimental animals. It carries some 500 head of cattle and 200 horses and mules. Some of these are in long-term breeding and nutritional experiments.

The present mobile laboratory.



A scene inside the mobile laboratory.

The Mobile Laboratory

It is frequently essential to carry out laboratory investigations at the site of an outbreak of disease. For this purpose mobile laboratories are employed.

The photograph below shows the first mobile laboratory sent out from Onderstepoort in 1914.

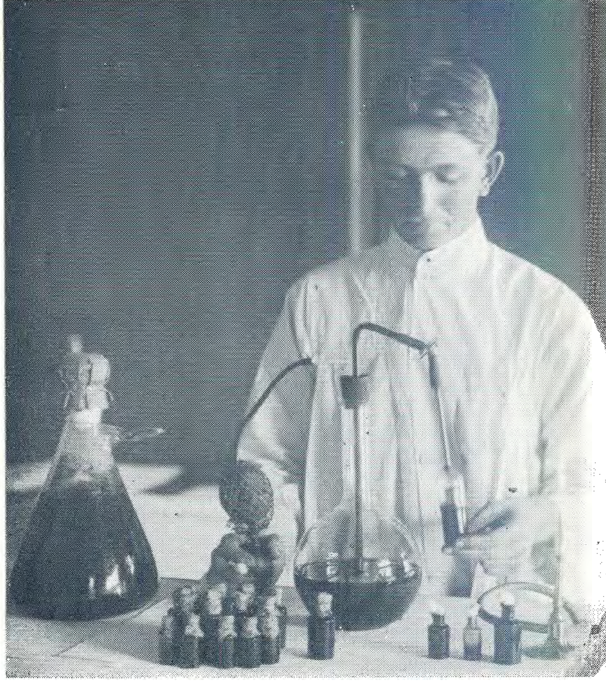
The present laboratory is shown on page 597. This was presented to the Division of Veterinary Services by the Stock Diseases Research Fund, at a cost of some £4,800. It was built in the workshops of the Council for Scientific and Industrial Research and is fully self-contained. It was officially handed over to the Division of Veterinary Services in October, 1958, on the occasion of the fiftieth anniversary of Onderstepoort.

Fig. 27.—An early mobile laboratory, about 1914.

VACCINE PRODUCTION: ONDERSTEPOORT

Year July, 1957, to June, 1958

VACCINE	DOSES ISSUED
Anaplasmosis	417,900
Anthrax	8,366,800
Blackquarter	2,233,800
Bluetongue	22,587,400
Botulinus	3,107,300
Contagious Abortion	541,700
Distemper	24,200
Enterotoxaemia	9,776,000
Fowl Pox	3,974,900
Horsesickness	150,700
Lamb Dysentery	385,800
Newcastle Disease	192,000
Paratyphoid	375,700
Rabies	47,000
Redwater	45,000
Rift Valley fever	168,400



Bottling bluetongue vaccine in 1912.

The increase in annual vaccine production

YEAR	TOTAL DOSES OF VACCINE ISSUED
1908	112,700
1918	2,462,800
1928	5,815,400
1938	9,977,700
1948	13,060,300
1958	67,943,700

RESEARCH PROJECTS

At present research into the following problems is being conducted at Onderstepoort:—

Anatomy

Malformations and hereditary defects of animals; comparative studies on hair and hair follicle morphology in domestic and wild animals; development of histological techniques.

Bacteriology

Research into blue udder; brucellosis of cattle and sheep; botulism; clostridial infections; tuberculosis including the use of I.N.H.; leptospirosis; listeriasis, salmonella infections and bacterial mycotic diseases in general.

Blood Grouping

Blood groups in animals, with special reference to endogenous African cattle.

Chemistry and Biochemistry

Estimation of amino acids and vitamins; biochemical studies on microbial metabolism and growth; phosphate supplementation; effects of fluorine; survey of trace elements; vitamin A studies; nutritional value of fish meals.

A scene in the central bottling section, 1958.

Chemical Pathology

Blood constituents in health and disease; toxicity of anthelminthics.

Medicine

Research into clinical medicine.

Pathology

Neoplasia in domestic animals; histopathology produced by plant poisons; pathology of the skin; goitre; pathology of the liver; pathology of the nervous system.

Parasitology

The blowfly problem; evaluation of insecticides; helminth parasites; infectious itch of sheep; tick paralysis; sheep scab; trematode infections; sucking lice of mammals; tick survey (systematics and bionomics of African ticks); control of verminosis in high rainfall areas; survey of internal parasites in stock in South Africa.

Physiology

Digestion and metabolism in ruminant animals; hepatogenic photosensitisation.

Protozoology

Anaplasmosis; babesiosis; besnoitiosis; coccidiosis; sweating sickness and tick toxicosis; theileriosis and gonderiosis; trypanosomiasis.

Poultry Pathology

Breeding to decrease the incidence of cancer and improve production; effects of relaxed selection in closed flock; pleuro-pneumonia-like organisms; poultry and avian diseases in general.

Reproduction

Artificial insemination of domestic and wild animals; functional and infectious infertility of domestic animals; normal sex physiology.

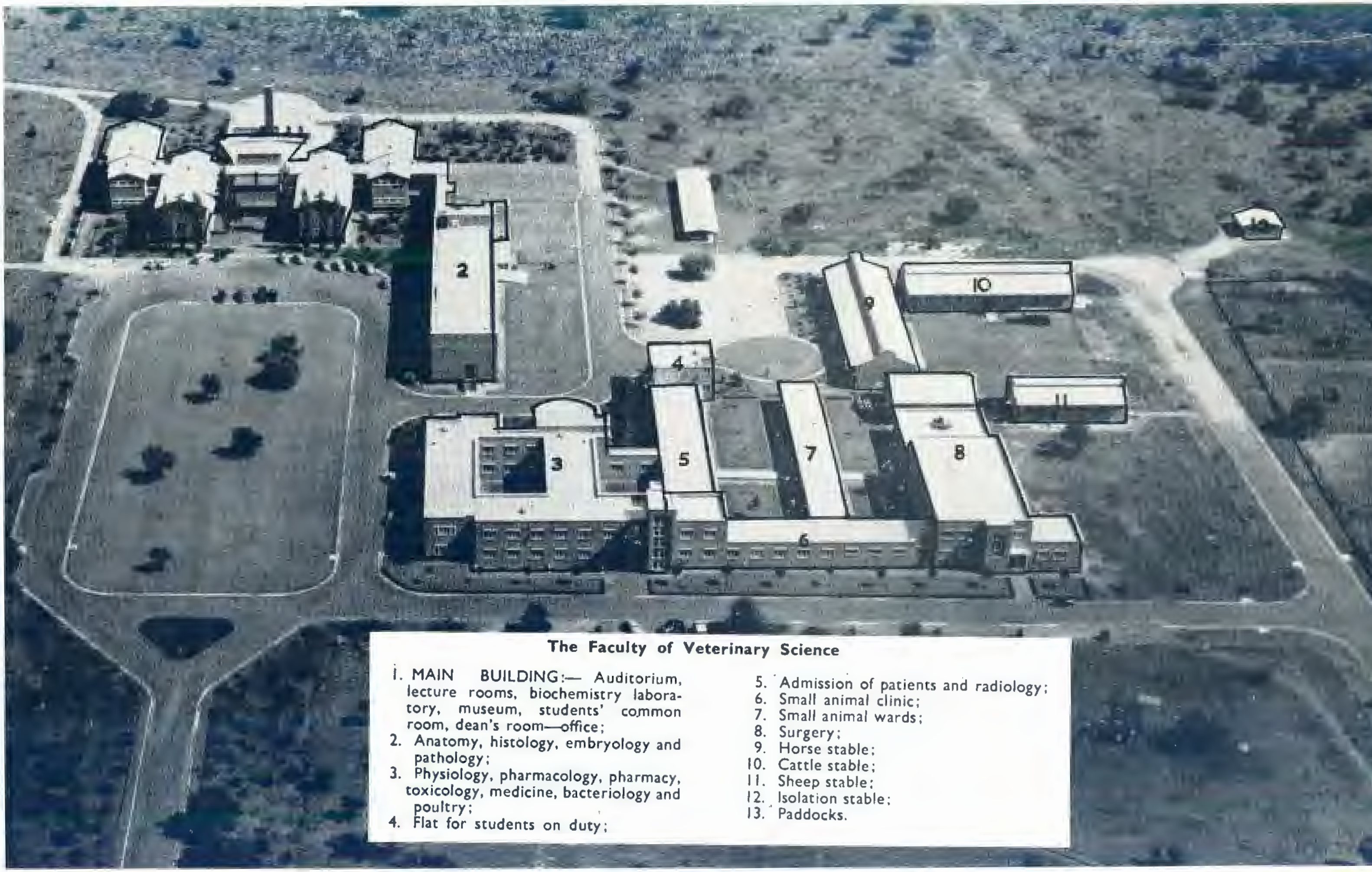
Surgery

Research into surgery of animals.

Toxicology

Inorganic and mineral poisons; plant poisons; poisoning by insecticides; etc.

Dr. P. J. J. Fourie, M.R.C.V.S., Dr. Med. Vet. (Utrecht).
Dean of the Faculty. 1950–1955.



An aerial view of the faculty buildings.

Dr. H. Graf, B.Sc. (S.A.), D.V.Sc. (S.A.).
Dean of the Faculty from 1956.

Virology

African swine fever; bluetongue; distemper; fowl pox; heartwater; horse-sickness; lumpy skin disease; Newcastle disease; rabies; Rift Valley fever; virus pneumonia of pigs; Wesselsbron disease; tissue culture technique; African arthropod-borne viral diseases.

The Faculty of Veterinary Science

The Faculty of Veterinary Science at Onderstepoort was founded in 1920. Prior to that date the veterinary needs of the country had been met by the importation of veterinarians from overseas and by a system of scholarships whereby South Africans were sent overseas for training. It was felt, however, that veterinarians should be trained in South Africa, especially in view of the presence of many purely African diseases with which the South African veterinarians had to contend.

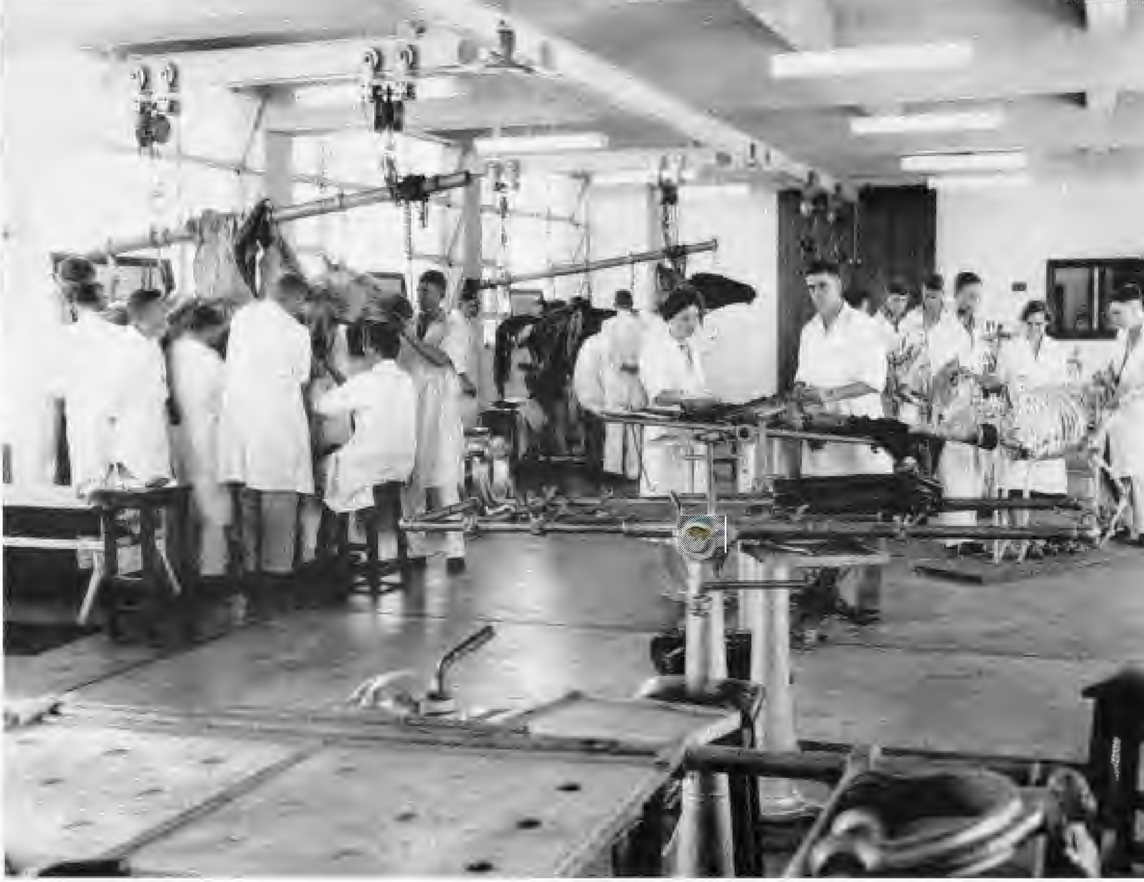
The establishment of a veterinary faculty was first mooted in 1915, but it was not till 1919 that the Minister for Education appointed a committee to investigate the matter. This committee reported that the need for a faculty was urgent and recommended that the last three years of vocational training should be done at Onderstepoort or in Pretoria, in view of its proximity to Onderstepoort. It was decided to establish the last three years at Onderstepoort—the training to be undertaken by the existing staff on a part-time basis—and Sir Arnold Theiler was appointed as the first Dean. The faculty was to form part of the Transvaal University College, a constituent college of the University of South Africa. The first two years of the curriculum could be followed at any University or University College with the required facilities. As the first year subjects in the basic sciences were available at almost all Universities, this presented no problem, but the second year required facilities to teach veterinary anatomy, general physiology and biochemistry. Both the Transvaal and the Johannesburg University Colleges offered such courses during 1920, and the latter reserved the right to establish a full veterinary course should they so decide. Students who had completed the second year either at Pretoria or Johannesburg, proceeded to

The faculty buildings.

Onderstepoort, where a hostel had been erected. The first group arrived at Onderstepoort in 1921 and graduated in 1924. At the end of 1924 the course in Johannesburg was closed, and in 1926 the second year was moved from Pretoria to Onderstepoort. The position to-day is, therefore, that students can take the first year at any approved University (not necessarily in South Africa) and then apply for admittance to the Faculty of Veterinary Science at Onderstepoort, where they commence the second year curriculum. In 1930 the Transvaal University College was granted university status and the Faculty became part of the University of Pretoria. Both official languages of the Union (English and Afrikaans) are used in the Faculty and this system has worked very well.

For many years the number of students seeking admission rarely exceeded 15 per year. During the early 1930's even this figure was reduced. With the post-war boom, however, the number of applicants rose sharply and a very strict selection was instituted. The available accommodation for teaching, all improvised in the institute, would not allow of classes of more than 20 at the most. At the same time the divisional activities were expanding rapidly, with consequent demands on the personnel, space and equipment. The Government therefore decided to erect a complete Faculty complex on a separate site but still in the grounds of Onderstepoort, and the buildings were completed at the end of 1954 at a cost of £500,000. The Faculty moved in at the beginning of 1955. At the same time the hostel was enlarged to accommodate over 100 students and the admittance to the second year was raised to 30.

It soon became evident that the rapidly expanding Faculty could no longer be staffed by part-time personnel alone, and the suggestion (which had long been mooted) that the Faculty should go over completely to the University, gained increasing support. At the same time it was fully realized that both the Faculty and the institute gained immeasurably from their very close integration, a position which is possibly unique. Finally a compromise was reached by which five departments of the Faculty became " full-time " and four others remained " part-time ", at least for the time being. The old Faculty was disbanded and all posts readvertised on the new basis.



The anatomy hall.

The Faculty is now constituted as follows:—

Full Time Departments

1. *Anatomy*. Head: Prof. H. P. A. de Boom.
   Including Histology and Embryology.
   Other staff: One Senior Lecturer and one Lecturer.
2. *Physiology*. Head: Prof. R. Clark.
   Including Biochemistry and Chemical Pathology.
   Other staff: One Associate Professor, two Senior Lecturers.
3. *Medicine*. Head: Prof. K. van der Walt.
   Including Pharmacology and Ambulatory Clinic.
   Other Staff: Two Senior Lecturers.
4. *Surgery*. Head: Prof. C. F. B. Hofmeyr.
   Including Gynaecology, Andrology, Obstetrics and Artificial Insemination.
   Other staff: Two Senior Lecturers.
5. *Pathology*. Head: Prof. K. C. W. A. Schulz.
   Including Special Hygiene.
   Other staff: One Associate Professor, one Senior Lecturer.

Part Time Departments

6. *Infectious Diseases*. Head: Prof. R. A. Alexander.
   Including Viral, Protozoal, Bacterial and Mycotic Diseases.
   Other staff: Two Associate Professors, two Senior Lecturers, one Lecturer.

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One of the operating theatres.

7. *Parasitology.* Head: Prof. R. M. du Toit.
   Including Entomology and Helminthology.
   Other staff: One Senior Lecturer.
8. *Poultry Pathology.* Head: Prof. J. D. W. A. Coles.
   Including all aspects of Poultry Pathology and Husbandry.
   Other staff: One Senior Lecturer.
9. *Zootechnics.* Head: Prof. J. H. R. Bisschop.
   Including Animal Management, General Hygiene, Nutrition and Pasture Management.
   Other staff: Three Senior Lecturers.

All the Faculty staff is employed by the State but receive additional allowances from the University. The first duty of the staffs of the full-time departments is Faculty affairs. The buildings and all equipment are supplied by the Department of Agriculture.

The curriculum for the degree of Bachelor of Veterinary Science is as follows:—

First Year:—

1. Botany
2. Chemistry
3. Zoology
4. Physics

Second Year:—

1. Systematic Anatomy
2. Histology
3. Embryology
4. Physiology
5. Biochemistry
6. Animal Management and General Hygiene*
7. Zootechnics*

Third Year:—

1. Comparative and Topographical Anatomy
2. Applied Physiology
3. Pathological Physiology
4. Pathology I
5. General Protozoology and Virology*
6. General Bacteriology
7. Entomology
8. Zootechnics
9. Animal Management and General Hygiene
10. Nutrition*
11. Pasture Management

Fourth Year:—

1. Chemical Pathology
2. Medicine*
3. Pharmacology
4. Toxicology
5. General Surgery
6. Pathology II
7. Special Hygiene*
8. Infectious Diseases*
9. Helminthology
10. Poultry
11. Nutrition

Fifth Year:—

1. Medicine
2. Surgery
3. Gynaecology
4. Pathology III
5. Special Hygiene
6. Infectious Diseases
7. State Veterinary Medicine
8. Poultry Pathology

* Indicates attendance course with examination in a later year.

A scene in the medical clinic.

Mr. Coert Steynberg handing over a bust of Sir Arnold Theiler to Prof. H. O. Mönnig. The bust now stands in the entrance to the main faculty building.

Apart from their normal duties, the fourth and fifth year students attend an out-of-hours clinic and the ambulatory clinic which visits farms within a fifteen-mile radius of Onderstepoort.

The Faculty also offers the degree of Doctor of Veterinary Science, in part fulfilment for which a thesis is demanded.

The general appearances of the Faculty buildings and of some of the laboratories and clinics are best conveyed by the illustrations, and no verbal description will be attempted.

Some Veterinary Problems and Triumphs during the past Fifty Years

A. Virus Diseases

Bluetongue

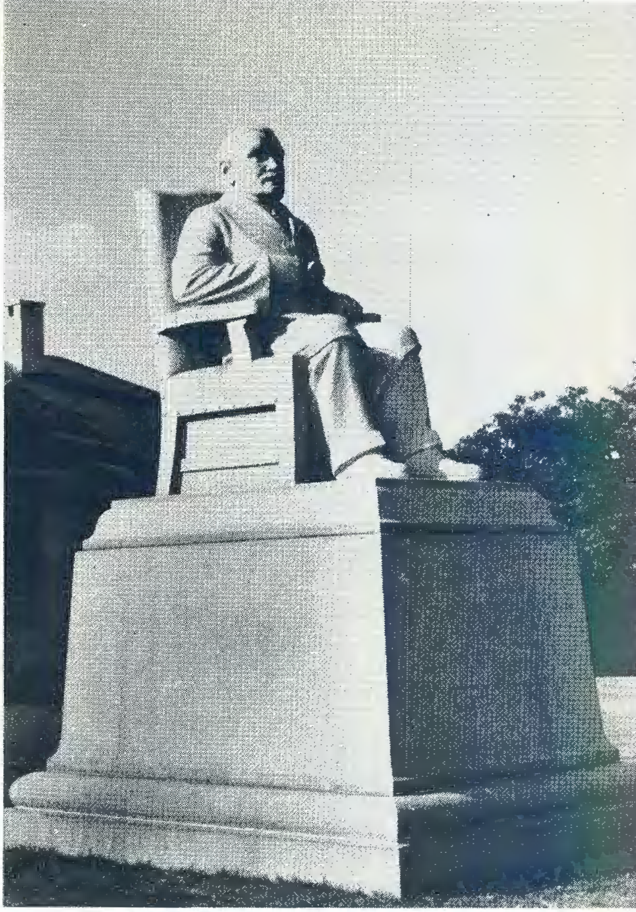
Bluetongue, which causes serious losses among sheep, was for many years confined to Southern Africa and for this reason all the pioneer research work and subsequent development of a polyvalent vaccine was done at Onderstepoort.

Bluetongue probably occurred in South Africa long before European breeds of sheep were introduced into the country. A description of a disease of sheep (probably bluetongue) occurring in low-lying pastures and valleys was published in 1876.

Although Hutcheon (1880, 1883) and Spreull (1901, 1902) contributed towards the knowledge of the disease, it was not until 1905 that Theiler showed that a filterable virus was responsible for bluetongue. The strain he isolated was relatively avirulent and Theiler considered that it was attenuated by serial passage in sheep. The first vaccine consisting of the blood of infected sheep, was introduced during 1906 and was used until 1946, by which time more than 50 million doses had been issued.

Although the vaccine afforded reasonable protection, it did not produce an adequate immunity at all times and caused severe reactions and economic losses among highly susceptible breeds.

During this time, intensive research had been carried out on various aspects of the disease, including studies on immunity. A notable advance was made in 1944 when it was shown that a plurality of antigenically different strains of virus existed and that the virus could not be modified by passage through sheep. These discoveries revealed the shortcomings of Theiler's vaccine and stressed the need for further research on the propagation and attenuation of the virus in the laboratory. In 1940 the cultivation of the virus in embryonated eggs was achieved, but great difficulty in maintaining virus strains by serial passage was encountered. A detailed study of the factors affecting the growth of the virus in embryonated eggs showed that for optimal virus multiplication inoculated eggs should be incubated at a temperature of 33·5° F. This achievement led to the attenuation of a number of strains of virus and the production of a quadrivalent, avianized bluetongue vaccine in 1948. This vaccine gave good results in the field but, owing to the lack of a suitable method for typing strains, those incorporated in the vaccine only represented isolates from major outbreaks of the disease and were selected on cross-immunity experiments. Consequently, breakdowns in immunity following natural infections with antigenically different strains, occurred at times in various areas.



The statue of Sir Arnold Theiler carved by Coert Steynberg.

The next achievement was the demonstration in 1956 that bluetongue virus possesses cytopathogenic activity for lamb kidney cells in culture. The inhibition of cytopathogenesis by homologous antibody in sheep serum provided a test by which virus strains could be typed. According to work which is now in progress, it appears that a large number of antigenically different types of bluetongue virus exists in nature, the number probably being not less than 13. Incorporation of this number in a single vaccine to be administered by a single injection is a major problem.

The finding that bluetongue virus can be propagated in lamb kidney cell cultures led to the preparation of a satisfactory complement-fixing antigen for the detection of bluetongue antibodies in the serum of sheep. Previously the lack of a satisfactory antigen was the main obstacle in the development of such a test, which has been shown to be of great diagnostic value by virtue of its group specificity.

The virus of bluetongue has also been adapted to multiply in the brains of sucking mice.

The size of bluetongue virus has been determined by filtration and ultracentrifugation and is estimated to be between 100 and 150 millimicrons.

Because of its seasonal occurrence it was long suspected that bluetongue was transmitted by insects. It was not until 1944, however, that a major contribution in this respect was made, when it was shown that wild-caught Culicoides species could harbour the virus and transmit the disease while sucking blood about 10 days after an infective feed. It still remains to be established what the inter-epizootic reservoir of infection is. The virus has been isolated from wild-caught rodents (*Rhabdomys* and *Otomys* species); on the other hand it has been demonstrated that cattle can harbour the virus in the blood for periods of up to 12 weeks in spite of circulating homologous antibodies.

The pathology of bluetongue in sheep has been extensively studied. Severe muscular degeneration develops in sheep suffering from the disease. Exposure to direct sunlight has been shown to increase the severity of the symptoms.

Although bluetongue was confined to Southern Africa for many years, the disease has subsequently spread to other parts of the world. Onderstepoort has played a very important part in diagnosing the disease and in recommending control measures in these countries.

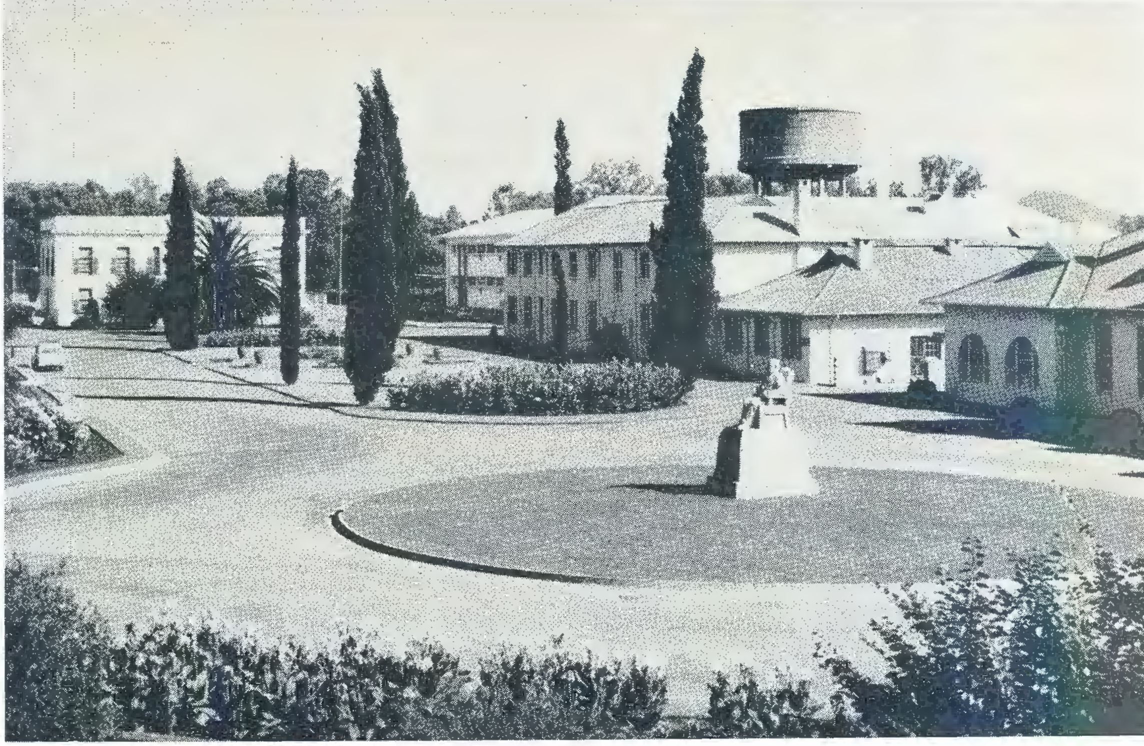
In 1952 a strain of bluetongue virus isolated in Israel was identified at Onderstepoort. In 1953 the Director of Veterinary Services for the Union of South Africa (Dr. R. A. Alexander) was invited to visit the United States of America to give expert advice on bluetongue, which had made its appearance among sheep in California. The identification of the virus was carried out at Onderstepoort.

During 1956 an outbreak of bluetongue in Portugal and Spain was identified with the assistance of workers at Onderstepoort, and the routine vaccine as produced in embryonated eggs was found to produce full protection in immunized sheep.

Horsesickness

There is no doubt that horsesickness was encountered by the early Cape settlers during the rule of the Dutch East India Company, and records show that it had been recognised even earlier in East and North Africa. With the spread of civilization northwards it was found that the disease was enzootic in many of the more subtropical parts of the country. Periodically severe epizootics would sweep over almost the entire country, and in one such outbreak 40 per cent of the total horse population is reported to have died. In the days before mechanical transport the horse played a vital role in all spheres of life, and the presence of horsesickness was a severe handicap to the development of the country. " Salted " horses (i.e. animals recovered from natural infection) realized fabulous prices.

In 1900 the viral nature of the disease was demonstrated independently by M'Fadyean, Theiler and Nocard by its transmission with filtered material. In 1905 Theiler introduced a method of immunization using virulent virus and hyperimmune serum. Although it represented a tremendous advance, this method was cumbersome and costly and breakdowns in immunity were frequent. Furthermore, a small percentage of horses died some months after immunization from " Staggers " or " Acute Liver Atrophy ", which was thought to be associated with the large doses of hyperimmune serum administered. Despite these disadvantages the method was used extensively for nearly 25 years and proved an enormous boon to the country, particularly for the immunization of mules.



Looking west towards the library.

During this time Theiler proved a plurality of immunological strains which explained many of the breakdowns.

It had long been known that stabling horses at night reduced the incidence of the disease and it was common practice to smoke such stables by lighting dung fires in them. It was also noted that the severity of the disease in the enzootic areas was greatest towards the end of the rainy season and that it followed very closely the incidence of malaria in humans. Furthermore, it was found that the spread of the disease in epizootic form coincided with exceptionally wet summers. These observations led to the incrimination of a " night flying, biting insect " as the vector, but it was not till 1944 that the role played by Culicoides species was experimentally proved at Onderstepoort.

Following the production of a formolized virus vaccine against Canine Distemper by Laidlow and Dunkin (1900) the adaptation of this method to horsesickness was attempted but the results were disappointing.

The next major advance was in 1931, when it was found that the horsesickness virus could be transmitted to mice by intracerebral injection and that serial passage produced a neurotropic virus which was attenuated but fully antigenic when given to horses subcutaneously. This discovery not only led to the production of an effective, safe and convenient vaccine, but also made detailed studies of the virus possible. By means of a " mouse protection test " the various antigenic strains could be isolated. It was subsequently found that there are seven basic antigenic types and all are now incorporated in a polyvalent vaccine which is issued in freeze-dried form.

Owing to this vaccine horses can now be kept with virtual impunity in areas where, 50 years ago, the diggers would have paid a fortune in gold dust for a salted horse.

It has also been shown that the transfer of antibodies from an immune dam to her offspring is solely via the collostrum. This is of importance in the immunization of such foals, as the acquired antibodies neutralise the antigenic action of the virus and so prevent the active immunization of such foals until they are some six months old.

The physical properties of the virus have also been studied by ultracentrifugation and electrophoresis techniques.

While the method of preparation of the neurotropic virus vaccine was being perfected and the antigenic relationship of the various virus strains was being studied, types of each virus group were adapted to propagation in the developing chick embryo. No decision has yet been taken as to whether the egg-attenuated virus is not, in fact, the virus of choice for routine immunization.

Heartwater

Heartwater is an acute infectious disease of cattle, sheep and goats and is of enormous economic importance to South Africa, and the African Continent, to which it appears to be confined.

In the Union, the disease is enzootic in the whole of the Northern Transvaal and along the coastal strip as far south as Mossel Bay. It has been known for at least a century, and as early as 1900 Lounsbury showed that it could be transmitted by the tick *Amblyomma hebraeum*. Later *A. pomposum* was also shown to be a vector.

It was generally accepted that heartwater was caused by a virus until 1926, when Cowdry, then at Onderstepoort as a guest worker, and following up a suggestion made by Sir Arnold Theiler, demonstrated a *Rickettsia* in the endothelial cells of the blood vessels of infected animals. He also found Rickettsia in the alimentary tract of *Amblyomma* species and reproduced the disease with infected ticks.

The disease can only be transmitted artificially with certainty by the intravenous injection of infected whole blood. It was found that the infective agent was firmly attached to the blood cells and was not filterable.

Despite numerous attempts, an attenuated strain of heartwater has not been isolated or developed. Techniques that have been tried include serial passage through ferrets, mice and sheep, and attempted cultivation in eggs and on tissue cultures. There is therefore, as yet, no vaccine against heartwater.

Up till 1939 there was also no known treatment for the disease, so that eradication of the tick remained the only possible means of control. This was rendered extremely difficult not only owing to the huge expanse of often wild country involved, but also because the *Amblyomma* have an exceedingly wide range of hosts, including many wild species which cannot be controlled. Furthermore, it was proved that certain species of game, namely, the blesbuck (*Damaliscus albifrons*), the black wildebeest (*Conochaetes gnu*) and the springbok (*Antidorcas marsupialis*), were susceptible to heartwater. Although they do not always show symptoms they may act as carriers of the disease. The same may apply to many other species. In addition it has been found that, following either natural or artificial infection of an immune animal after the normal period of incubation the infectious agent will circulate in the peripheral blood to serve as a source of infection for the insect vector.

The Library. This building was erected in 1932 as a gift to Onderstepoort by the Empire Marketing Board. It houses some 22,716 volumes and over 700 different journals are received annually.

It had long been known that animals reared on " heartwater veld " frequently survived, although the mortality among importations from non-infected areas was very heavy. This was later found to be due to the fact that calves up to the age of three to four weeks are extremely resistant to heartwater, but develop an immunity if infected during that period. A partial reduction of the number of ticks can therefore reduce the chances of a new-born calf becoming infected, and so lead to an increase in the number of susceptible animals in the herd, with greater losses among them.

The economic importance of heartwater in the infected areas is not confined to the actual losses. Owing to the fact that animals imported from non-infected areas almost always succumb within one or two summers, it has been almost impossible to bring in new blood and improve the cattle in the heartwater areas. Well-bred dairy cattle are particularly susceptible, so that the development of the dairy industry in these areas has been specially retarded, to the detriment of the whole country.

In 1939 it was found that Uleron and other sulphonamides had a specific therapeutic action against heartwater. This not only made treatment possible, but also immunization by artificial infection and subsequent treatment. It was during the course of this work that the resistance of the new-born calf was discovered. Later, aureomycin and terramycin were found to be considerably more effective than the sulphonamides. It was also found that a " blocking " dose given during the incubation period did not interfere with the development of immunity, although it might completely suppress the febrile reaction.

The way was now open for the large-scale immunization of calves. The infective dose used is sheep's blood, drawn at the height of the febrile reaction. All infected calves are kept under observation and those showing severe reactions are treated. As a result, the losses due to heartwater are being dramatically reduced. Dairy herds are being built up from calves immunized before introduction. The immunization of adult animals is more dangerous and costly and requires close veterinary supervision. Nevertheless, large numbers of breeding stock are being immunized and imported into the heartwater areas with a consequent improvement of the stock. Sheep and goats can also be immunized.

It has been found that the immunity tends to wane unless boosted by periodic re-infection. For this reason animals should be immunized not more than six months before being introduced on to heartwater veld.

These discoveries have opened up a new era in stock farming in the heartwater areas, but the final triumph will be the discovery of a safe and efficient vaccine, which in turn will be dependent upon the artificial propagation of the rickettsia. Viable rickettsias have been maintained for long periods at temperatures below $-50°$ C, but so far no one has succeeded in maintaining a strain by propagation outside the animal body.

A scene in the library.

Rift Valley Fever

In the autumn of 1951 a large-scale outbreak of what was apparently a new disease among sheep and cattle occurred in the Orange Free State. Affected animals showed a high fever complicated by jaundice, and mortality was heavy. Abortion, especially among ewes, was extremely common. Very soon it was found that a large percentage of persons who conducted post-mortem examinations on such animals subsequently contracted an illness resembling very severe influenza, but again complicated by jaundice. This was no disease previously encountered in the Union, but workers at Onderstepoort quickly realized that it corresponded to a disease which had been described in Kenya in 1931 and named " Rift Valley fever ". The identity of the two diseases was established by suitable laboratory tests based upon the use of specific immune serum obtained from the Veterinary Laboratory, Kabete, Kenya, and a strain of virus obtained from the Rockefeller Foundation Research Unit, Entebbe, Uganda.

Rift Valley fever is known to be carried by mosquitoes, and one species (*Aedes caballus*) was shown to be present in the infected areas and to be capable of transmitting the disease.

By conducting a survey of the presence of specific antibodies in the sera of animals and man in different parts of the country, a start was made in determining the geographical distribution of the disease. By this means it was shown that, in addition to the Free State, the disease was continuously present in the Knysna district of the south-eastern Cape Province. Annual tests have since shown a progressive increase in the number of immune animals, without any clinical evidence of the disease being present apart from an occasional abortion. It is concluded that the Knysna area represents an enzootic focus of infection.

It was early apparent that prophylactic vaccination was the only practical method of combating the disease, and here again the work previously done in Kenya and Uganda saved the Onderstepoort laboratories many months of labour. Smithburn had maintained a strain of virus by serial passage through the brains of 85 serial groups of mice and had shown this virus to have become attenuated for sheep. This virus was made available and after one further passage in mice and ten in embryonated eggs was confirmed as being suitable for use as a vaccine. It gave good results but tended to cause abortion in pregnant animals. Further work produced a strain which was safer, although less potent as an immunizing agent. It had passed 102 intracerebral passages in mice and 54 in embryonated eggs. The vaccine was again improved later by using a neurotropic strain produced by 102 passages through the mouse brain alone.

The vaccine is issued in freeze-dried form and difficulty was encountered in finding a suitable diluent. The usual phosphate buffer-lactose-peptone solution used for other viruses was found to be unsuitable because the virus was destroyed. This was found to be due to the phosphate buffer. The diluent now used is 5 per cent peptone in distilled water.

Outbreaks of Rift Valley fever occur periodically, especially in very wet years, and the vaccine, now combined with Wesselsbron vaccine (q.v.), is giving good results in the field.

Wesselsbron Disease

During the late summer of 1954–55 an outbreak of disease was reported in a flock of Merino sheep in the Wesselsbron district of the Orange Free State. Mortality first occurred among new-born lambs, and later abortions and deaths among the ewes were observed. As the owner had inoculated his pregnant ewes against Rift Valley fever two weeks previously, it was thought that the vaccine might be responsible, but investigation revealed the presence of a completely new virus antigenically distinct from that of Rift Valley fever. This was named Wesselsbron virus.

Using the same techniques as for Rift Valley fever, it was shown that the two viruses had a very similar distribution in Southern Africa and that the newly discovered virus had been present in the Knysna area at least prior to 1954. Antibodies to Wesselsbron virus were also demonstrated in serum samples from sheep and cattle collected in Southern and Northern Rhodesia and Nyasaland.

The virus was found to be pathogenic for a wide range of domestic and laboratory animals. As with Rift Valley fever, many of the humans exposed to infection contracted the disease.

The virus has been propagated in infant mice, embryonated eggs and lamb kidney tissue cultures. Finally a modified virus suitable for use as a vaccine strain was produced from the brains of infant mice injected intracerebrally. Although the vaccine strain gives full protection and is safe when used on non-pregnant animals and day-old lambs, its affinity for embryonic tissue causes it to produce abortions, extended pregnancy and hydrops amnii in pregnant animals, with histopathological changes of viral encephalitis in the foetal brain.

The vaccine is issued in combination with the Rift Valley fever vaccine, with specific instructions that it should not be used on pregnant animals. Where these instructions are observed it has given very good results in the field.

Lumpy Skin Disease

In 1943 a disease of cattle characterised by nodule formation in the skin was reported from Ngamiland. The following year the disease appeared in the Union and was immediately investigated at Onderstepoort. Its infectious nature was proved by transmission experiments using suspensions of nodular material. The histopathology of the nodules was also studied and intracytoplasmic inclusion bodies were found in the histiocytes and epithelial cells of the skin lesions. In the absence of any apparent specific bacterial infection, the disease was presumed to be of viral origin.

Suddenly the disease spread over the country as an uncontrollable epizootic and the veterinary authorities were faced with a new problem of vast economic importance. With his usual aptitude for naming stock diseases, the South African farmer promptly called the new scourge " knopvelsiekte ", or lumpy skin disease. The nodules vary from about one to more than four or five centimetres in diameter and frequently necrose to become deep-seated sitfasts, which may become the site of secondary infection. The disease not only attacks the epithelium of the skin but also that of other organs such as the respiratory tract, when sudden death due to asphyxia may result. Sterility in both sexes due to lesions in the genital organs is a common sequel. The disease also causes tremendous economic losses due to loss of milk yield, and condition, and the virtual ruination of the skin.

A typical case of Lumpy Skin disease.

Despite all efforts to control the disease by isolation of infected herds and restriction of stock movements, it spread rapidly over the greater part of the country, often jumping great distances. In the meantime research work went on steadily.

It was shown that the blood and saliva of infected animals are infected, but only for a limited period during the febrile reaction. The nodules, however, continue to harbour the virus for at least five weeks after their appearance and even necrotic sitfasts may be infective. Recovered animals develop an immunity, the duration of which has still to be determined accurately.

As the epizootic subsided, research work was hampered by the fact that a large proportion of animals had developed a natural immunity and there was no serological technique whereby immune animals could be identified. Transmission experiments were therefore difficult to interpret.

In 1948 Van den Ende, working in Cape Town, isolated a virus from nodular material by cultivation in embryonated eggs and hopes ran high until it was proved that this was not the cause of lumpy skin disease. In the same year a virus was isolated by the same techniques at Onderstepoort but could not be maintained by passage either in cattle or any of the usual laboratory animals, or in eggs.

In 1956 the technique of growing viruses on tissue culture was applied to lumpy skin disease and since then a large number of isolates have been obtained and maintained, using calf kidney cells as the culture medium. These viruses fall into three groups.

The first group of which more than a dozen identical strains have been isolated, has been found to be orphan viruses, i.e. they produce no disease. All produce characteristic cytopathogenic changes with intranuclear inclusion bodies in the culture cells and all possess a common complement fixing antigen.

A second group of viruses is characterised by the formation of large syncitia in kidney cell cultures with intranuclear inclusions in the affected cells. They produce clinical lumpy skin disease in cattle, but the lesions are superficial and the histopathological changes are similar to those seen in the tissue culture cells. After 50 serial passages in culture, one of these strains failed to produce clinical symptoms in cattle but caused the production of neutralizing antibodies.

A third group of viruses was finally isolated. These produce monocytial changes in cultures of lamb and calf kidney cells with the formation of intracytoplasmic inclusion bodies similar to those produced by the pox group of viruses. They produce clinical lumpy skin disease in cattle, with deep-seated lesions, the histopathology of which corresponds to that of natural cases of the disease. Attempts to " attenuate " members of this group by serial passage in tissue culture have not yet succeeded.

Lumpy skin disease is now endemic in the country and outbreaks occur sporadically. From an economic point of view it is undoubtedly one of the gravest problems facing the veterinary authorities. Although no vaccine is as yet available, the achievements to date hold high promise for the future.

Rinderpest

The part played by Theiler in the catastrophic outbreaks of rinderpest at the end of the last century has been described under the early history of veterinary science in South Africa. Although the disease has not appeared in the country since 1903, Onderstepoort was directly connected with a large-scale campaign against it in Tanganyika in 1939. In that year it was decided by inter-territorial agreement to launch a campaign to halt the southward spread of the disease by creating a wide zone of immunized cattle along the southern boundaries of Tanganyika. The preparation of the required formalized spleen pulp vaccine was assigned to Onderstepoort and a small team, headed by the late D. T. Mitchell set out with a fully equipped field laboratory to produce the vaccine on the spot. By dint of improvisation, some million doses were prepared and the campaign was a complete success.

A tragic scene during the Rinderpest Outbreak of 1896.

Canine Distemper

To Onderstepoort must go the honour of having produced the first egg-adapted vaccine strain of distemper virus. This was achieved in 1948. Starting from a ferret-adapted strain, the virus was inoculated on to the chorio-allantoic membrane of pre-incubated eggs, which were subsequently held at 35° C. After 130 passages the virus was found to be effective and safe for the immunization of both dogs and ferrets.

This work attracted world-wide attention and numerous requests for the strain have been received from laboratories all over the world.

Three Day Stiffsickness of Cattle

Three day stiffsickness is a disease of cattle characterised by sudden onset, high fever and muscular paresis or paralysis. As the name implies, after a few days the symptoms abate as rapidly as they appear. Although mortality is low, the disease is of considerable economic importance on account of the complete interruption of milk yield, often with protracted recovery, which accompanies it.

The disease occurs mostly in late summer—in common with other conditions known to be insect-borne (e.g. horsesickness and bluetongue)—and is therefore thought to be carried by insects. Theiler first showed it to be infectious and transmitted it by subinoculation of blood.

Although the disease is undoubtedly caused by a virus, all attempts to cultivate the agent in the laboratory have so far failed.

East African Swine Fever

East African swine fever which occurs in the Union is antigenically quite distinct from the European disease, which does not occur in this country. The reservoir of infection is wild pigs, and large-scale outbreaks occurred in the past where domestic pigs had contact with wild species. The virus has been cultivated in embryonated eggs at Onderstepoort but a strain suitable for vaccine production was not obtained. The disease can be diagnosed histologically by specific changes in the kidneys. The method of control that has been adopted is the slaughtering out of all infected herds and the rigid inspection of pigs likely to contract the disease from wild pig species. Owing to these measures outbreaks are now rare and are rapidly stamped out when they do occur.

Infectious Anaemia of equines in South Africa

Equine infectious anaemia was first encountered in South Africa in 1913 by Theiler and Kehoe during experiments on the hyper-immunization of horses against horsesickness by the transfusion of large amounts of blood from reacting horses into immune animals.

They carried out a large number of experiments whereby they succeeded in transmitting the disease from horse to horse and also to mules and donkeys by the subinoculation of blood and urine.

The serum-virus method of immunization against horsesickness was practised during that time and Theiler and Kehoe recognised the danger of transmitting infectious anaemia virus with serum from horsesickness serum donors, unless these animals were carefully selected.

In 1918, De Kock confirmed the observations of Theiler and Kehoe and gave a detailed description of the disease in South Africa.

Bovine Malignant Catarrh (Snotsiekte)

From the early days it was known that cattle which came into contact with wildebeest were liable to develop a fatal disease characterised by a profuse nasal discharge and swelling of the lymph nodes. This condition was called " snotsiekte ". The disease was investigated at Onderstepoort by Mettam in 1924. He concluded that " snotsiekte " was not identical to malignant catarrhal fever described in Europe, as had been suggested by Theiler. Mettam proved that the black wildebeest acted as a carrier of the virus. In 1942 it was shown that apparently healthy sheep could also act as the reservoir for snotsiekte, in accordance with findings in connection with malignant cararrhal fever in Europe. The disease is rarely found in South Africa nowadays.

Fowl Pox

Fowl pox is widespread in South Africa and work at Onderstepoort showed that it is transmitted by the mosquito *Culex theileri.*

The first vaccine against fowl pox made in this country was prepared by Mitchell at the Allerton Laboratory in 1923. The virus was grown on the combs of cockerels and the vaccine was used on a small scale till 1932, when a pigeon pox vaccine was introduced.

In 1951 workers at Onderstepoort succeeded in growing fowl pox virus on the chorio-allantoic membrane of eight-day embryonated eggs. This virus is now used in the preparation of a vaccine of which some four million doses are issued annually.

Rabies

The first definite diagnosis of rabies in South Africa was made at Onderstepoort in 1929 by Du Toit, although reports indicate that the disease had been present as early as 1885.

Rabies is prevalent over a large proportion of the country. In the Northern Transvaal it occurs mainly among jackals and stray domestic dogs. In the Orange Free State it is enzootic among small wild carnivores such as meercats. Here relatively large numbers of cattle are affected, but dogs seldom contract the disease. Control measures differ therefore in these two areas. In the Northern Transvaal the policy is to destroy jackals and stray dogs and to immunise all domestic dogs. The destruction of the small wild carnivores is a very difficult problem but a large amount of work has already been done in this direction.

Over 100 specimens are received annually at Onderstepoort for the diagnosis of rabies and some 50,000 doses of Flury egg-adapted vaccine are prepared.

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Aerial spraying against Tsetse flies in Zululand.

Protozoan Diseases

Nagana

Even before the great European trek northwards from the Cape in 1836, nagana was well known to occur in the northern and eastern parts of what is now the Transvaal and in Swaziland and Zululand. The transmission of the disease by tsetse flies was also realized. At that time the disease occurred within 30 miles of where Onderstepoort now stands.

For some obscure reason the main vector (*Glossina morsitans*) gradually disappeared from the Transvaal and by 1896 only a small focus of infection remained in the Piet Retief district, where *Gl. pallidipes* acted as the transmitter.

The losses in Zululand were so heavy that Sir David Bruce was asked to investigate, and in 1895 he made the epoch-making discovery that the disease was caused by trypanosomes. This was the turning point not only in the study of nagana, but also in our knowledge of sleeping sickness in man and other diseases caused by trypanosomes.

One of the species isolated by Bruce was named *Trypanosoma brucei* and was long thought to be the main cause of Nagana in Zululand. Further investigations by Theiler in 1908 proved *T. congolense* to be the main culprit.

The history of nagana in Zululand is one of years of disaster and despair, culminating in complete triumph. The disease was enzootic among game, and in Zululand there are three game reserves of which the country is justly proud but which formed a bone of bitter contention for many years. Zululand was ideal cattle country except for nagana, and periodic epizootics decimated the stock. Suggestions that the game should be eradicated were bitterly opposed by the preservationists.

After the first world war many returned soldiers were granted farms in the area, but most were forced to abandon them due to the ravages of nagana.

In 1930 Harris introduced a trap based on the fact that the tsetse fly hunts by sight alone. The trap consisted of a hessian covered framework about four by three by two feet, open at the bottom and suspended in the bush about two feet from the ground. On top of this was a gauze cage with a funnel-shaped entry leading from the body of the trap. The flies mistook this object for an animal and darted at the underline, as is their habit. On turning upwards they entered the dark interior and, attracted to the light above, they entered the cage from which they could not escape. Thousands of flies were caught in this way and by 1933 there were 26,000 traps in operation. The fly population decreased steadily over the next four years and hopes of their eradication ran high but, despite the traps, both the fly and the incidence of nagana increased suddenly in 1937 and subsequent years.

In 1943 a game eradication campaign caused a storm of public protest and did little to reduce the fly population.

The eradication of Tsetse fly made 7,000 square miles of excellent grazing country available for cattle farming.

In the summer of 1945–46 a disastrous epizootic broke out and the disease spread far beyond its normal confines. Over an area of approximately 500 square miles over 60,000 deaths among cattle were recorded—the actual figure must have been much higher. Phenanthrodinium drugs* were applied on a very large scale with considerable success, but it was apparent that no final solution was possible other than the complete eradication of the tsetse fly.

By this time DDT was freely available from a local factory and experiments with aerial spraying were instituted in co-operation with the South African Air Force. Liquid spray was initially used but was discarded in favour of the smoke method. The DDT, dissolved in diesel oil, was introduced into the exhaust system of the aircraft and emerged as a dense aerosol fog.

The first area selected for spraying was one harbouring a dense population of *Glossina pallidipes*. It was some 30 square miles in extent and situated in the Mkuzi Game Reserve, which has a total area of 100 square miles. To the surprise of the workers it was found that monthly treatments of this relatively small area caused a dramatic drop in the fly population and, eventually, eradication of the fly throughout the whole of the reserve.

Investigations showed that the reason for this gratifying result was that the fly can only breed under very special conditions and in relatively restricted areas. Each season it disperses outwards from these centres for varying distances, depending on the season. Therefore, if the breeding areas could be located and cleared of fly the whole problem would be solved at a minimum of expense.

Fortunately the pupal case of the tsetse is extremely durable and can be recognised for up to two years after being shed. The presence of these pupal cases under the bush therefore indicates the breeding grounds. Parties were organised to hunt for pupal cases and the breeding grounds were mapped out. After two years work it was found that these areas occupied only some 280 square miles of the total 7,000 square miles which were periodically infested with fly. Intensive spraying of these breeding areas was started in 1946.

The results were checked with the use of tame bait animals, mostly cattle and pigs, tethered in the bush with a trained attendant standing by. The fly can easily be caught as it alights on the animal.

The last fly was caught in the Mkuzi game reserve in July, 1942, in the Umfolosi reserve in May, 1952, and in the Hluhluwe reserve in May, 1953. Surveys for adult flies were continued for three years after these dates and are in fact still in progress in Hluhluwe, but no flies have been seen.

Thus tsetse and nagana have been eradicated from their last stronghold in the Union and 7,000 square miles of excellent grazing country have been made available for cattle farming while still preserving our valuable heritage of game.

* It is of interest to note that no cases of photosensitization were encountered.

East Coast Fever and related diseases

From early records it would appear that East Coast fever was present in East Africa before the earliest European settlement. In 1897 Koch, who was investigating redwater in cattle near Dar-es-Salaam, reported finding, in addition to the red-water parasites, small rod-shaped, oval and round organisms in the blood cells of cattle.

In 1901 a group of cattle was imported from East Africa. Some were landed at Beira and moved to Southern Rhodesia while others were brought into the Transvaal at Komatipoort via Lourenco Marques. Mortality among these cattle spread rapidly and it was obvious that a new and highly dangerous disease had been introduced. The Southern Rhodesian Government appointed Koch, Klein and Gray to investigate the disease and Theiler immediately started work in the Transvaal.

The causal agent, *Theileria parva*, appears as small oval, rod-shaped or comma forms in the red cells. The plasma bodies (Koch bodies) found in the lymphocytes were thought to be a phase of the parasite, but it was not till 1910 that Gonder, working at Onderstepoort, proved conclusively that these bodies were in fact the schizogenous phase of *T. parva*. In 1903 Lounsbury showed that East Coast fever was transmitted by the " brown tick " (*Rhipicephalus* spp.). This was confirmed by Theiler in 1905.

In the meantime the disease had spread over the greater part of the Transvaal, Swaziland, Natal and along the Cape coast into the Transkei and East London areas. During the years 1910 to 1912 almost a million head of cattle died of East Coast fever in the Transvaal alone.

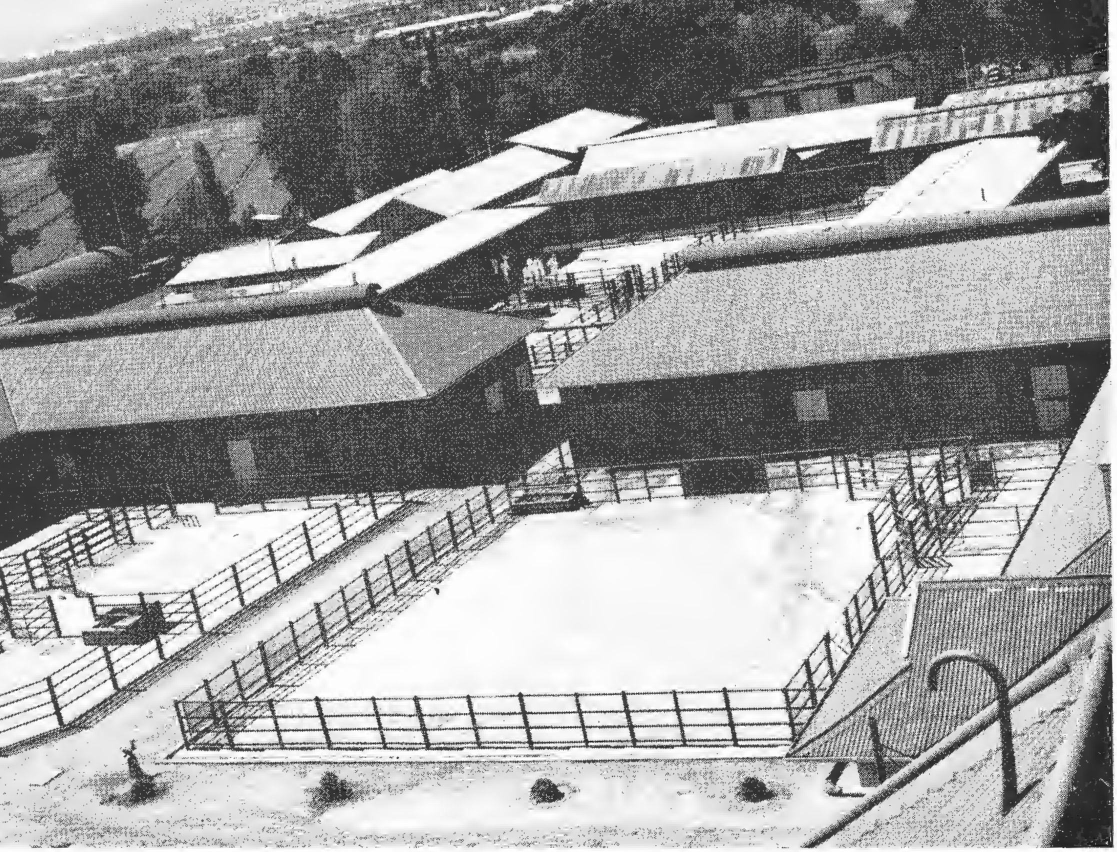
In the absence of any known immunizing or curative methods, the only means of fighting the disease lay in quarantine measures and regular dipping. Based on the life cycle of the tick, dipping was carried out every five days and quarantine was imposed for 18 months after the last death from East Coast fever. This entailed an immense organisation, as all cattle were checked at each dipping and spleen and lymph gland smears were demanded from all cattle which died or had been slaughtered since the last check. Many of the areas involved were Native reserves and dipping tanks had to be built in wild and inaccessible country. The stringent regulations necessarily caused considerable hardship to the farmers and seriously disrupted trade in cattle. This inevitably led to opposition and evasion. Despite these difficulties slow but steady progress was made, but the disease kept on breaking out again in areas thought to be cleared of infection.

By 1948 the incidence of the disease had been so reduced as to justify the adoption of the policy of clearing all infected farms of cattle and keeping them clear for a period of 18 months. This was based on two cardinal facts, viz.—

(*a*) if an infected tick feeds on a non-susceptible animal, such as any farm animal other than a bovine, it loses the infection; and

(*b*) if it does not find a host within 18 months it dies of starvation.

Keeping an area free of cattle for this period therefore ensures the elimination of the infection. The farm clearing policy was immediately successful and fully justified the expenditure entailed in compensation. The last outbreak of East Coast fever in the Union occurred in 1955 and we may confidently assume that the end of a long and arduous campaign is in sight, if not actually achieved.



Some of the tick-proof stables and exercising yards.

In 1906 Theiler described a mild disease in cattle, the causal agent of which closely resembled that of East Coast fever morphologically. He named the parasite *Gonderia mutans*. The presence of this infection was frequently an embarrassment in the control of East Coast fever as the two diseases could only be distinguished on epizootological grounds.

In 1953 extensive mortality occurred in a group of cattle which had recently been introduced into Zululand and which grazed in the corridor between the Mkuzi and Umfolozi game reserves. The condition closely resembled East Coast fever but the puzzling fact was that only the newly introduced cattle succumbed. Intensive research at Onderstepoort revealed that the disease was identical to one previously described in Rhodesia, and the causal organism was named *Gonderia lawrencei* (Neitz 1955) after its original discoverer. It was shown that the disease was essentially one of the buffalo, which, however, showed no symptoms. Cattle born in infected areas become immunized as calves.

Onderstepoort has contributed very largely to the knowledge of the group of diseases resembling East Coast fever which occur in many parts of Africa. At present work is proceeding on new drugs with a specific action against this group of parasites, and the results may be of benefit to the whole African continent.

Anaplasmosis (*Gallsickness*)

The successful investigation of anaplasmosis must be regarded as one of Theiler's most outstanding achievements. In 1893 Smith and Kilborne described coccus-like bodies on the margin of the erythrocytes of cattle suffering from redwater in the United States of America, but regarded them as a stage of the redwater parasite. In 1910 Theiler brought evidence to show that they were a distinct parasite and the cause of gallsickness. He further showed that there were two species, viz. *Anaplasma marginale* found on the margin of the erythrocyte and responsible for the severe form of gallsickness, and *Anaplasma centrale* found near the centre of the red cell and which caused a mild form of the disease. He further showed that infection with *A. centrale* caused a solid and lasting immunity against the virulent form of gallsickness. This is the basis of the present day vaccine which consists of the blood of cattle carrying *A. centrale*. Some 440,000 doses of gallsickness vaccine are issued annually.

In 1910 Theiler proved the transmission of *A. marginale* by the blue tick (*Boophilus decoloratus*) and showed that the infection passes through the egg. In 1912 he proved the same for *A. centrale*.

At present work is largely centred on the chemotherapy of the disease.

Redwater in Cattle (*Babesia bigemina* and *Babesia bovis* infection)

According to Wiltshire (1883), redwater occurred in Natal long before the arrival of European settlers. The causal organism was identified by Edington in 1896 as *Babesia bigemina*, which had been described in the United States of America by Smith and Kilborne. The disease is enzootic in many parts of the Union. In 1941 workers at Onderstepoort discovered that *B. bovis* was present in the country, having presumably been imported from Europe. This infection is widespread. The transmission of the disease by the blue tick (*Boophilus decoloratus*) had been worked out by American workers at the end of the nineteenth century.

In the enzootic areas, losses from redwater are limited by the fact that young calves are very resistant and develop a premunition to the infection. Severe losses are encountered, however, when adult cattle are moved from free or lightly infected areas to parts where the disease is severe. Regular dipping, especially where enforced under the East Coast fever regulations, did much to reduce mortality from both redwater and gallsickness.

In 1911, Theiler introduced a method of immunization based on the artificial infection of the animal and the control of the reaction with the use of trypan blue. Blood from carriers of *B. bigemina* was issued for the purpose. When the presence of *B. bovis* was established a bivalent vaccine, containing both parasites, was introduced.

It is recommended that in redwater areas calves be injected at the age of four weeks. Cattle to be introduced into infected areas should be immunized at least two months beforehand. The reaction must be checked by daily temperaturing and, where necessary, controlled by therapy. With the modern drugs available this presents little difficulty to a veterinarian.

Elephant Skin Disease (Bovine and Equine Cutaneous Besnoitiosis)

When and how bovine and equine besnoitiosis was introduced into the Union of South Africa is obscure. All that was known at the time when the disease was recognized by Schulz and Thorburn (1941) in a single horse in the Grahamstown district in the Eastern Cape Province, was that besnoitiosis had been described in France (Marotel, 1912), Portugal (Franco and Borges, 1916) and the Sudan (Bennet, 1933), and that it was apparently absent from Bechuanaland, Southern Rhodesia and Portuguese East Africa. Subsequent investigations revealed that it was fairly widely distributed in cattle in the Rustenburg district in the Northern Transvaal.

Surveys have shown that equine besnoitiosis only occurs sporadically in the Northern Transvaal and Zululand. The disease in cattle, however, is of great economic importance and occurs enzootically in the north-western, northern and north-eastern regions of the Transvaal. The mortality rate does not exceed 10 per cent, but affected cattle become unproductive and bulls invariably develop either a temporary or a permanent sterility.

A diagnosis of besnoitiosis can be established by demonstrating typical cysts in the skin, subcutis, aponeurosis of muscles, and in the mucous membrane of the upper respiratory tract. These cysts consist of markedly enlarged multinucleated histiocytes, which harbour several hundred spores.

Very little progress was made in the studies of the life-cycle of the parasite (*Besnoitia besnoiti*) until the disease was transmitted successfully to rabbits by means of blood derived from an actively affected bull. Affected rabbits developed symptoms similar to those occurring in cattle. These consist of fever accompanied by oedematous swelling of the limbs, ears, head, ventral region of the abdomen and external genitalia.

Microscopic examination of the blood and organ smears prepared during the febrile reaction and of skin sections during and after the convalescent period, revealed that the parasite divides by repeated binary fission. The complete absence of a sexual phase in the life-cycle of this protozoon disproved the theory advanced by previous investigators that *B. besnoiti* is either a coccidia or a gregarine, and revealed that it is related to *Toxoplasma gondii*, a parasite with a world-wide distribution.

Investigations on besnoitiosis are far from complete; the mode of transmission still needs to be determined before prophylactic measures can be applied. The hope is expressed that chemotherapeutic studies in progress at present will eventually lead to the discovery of a specific remedy. When this is achieved a safe method of immunization will be possible. This will involve the artificial infection of animals, and the control of the ensuing reaction with the remedy.

Biliary fever of horses (*Babesia equi* and *Babesia caballi* infections)

Biliary fever in horses is widespread in South Africa. The disease was first described in Natal by Wiltshire in 1883, but Theiler was the first to identify the causal agent as *B. equi*. In 1905 Koch found another parasite causing the same symptoms. This was named *B. caballi*. In 1906 Theiler showed that *B. equi* infection in South Africa is commonly transmitted by the red tick (*Rhipicephalus evertsi*). The transmission of *B. caballi* in this country has not yet been worked out.

With modern drugs, such as the accridine derivatives, treatment is usually successful provided it is instituted in the early stages of the disease.

Biliary fever of dogs (*Babesia canis* infection)

Biliary fever of dogs is rife in South Africa and in many areas practically every dog picks up the disease during its lifetime. The commonest transmitters are the " dog tick " (*Haemaphysalis leachi*) and the " brown dog tick " (*Rhipicephalus sanguineus*). The pathology and treatment of this disease have been the subject of intensive study at Onderstepoort, where hundreds of cases pass through the Faculty clinic annually.

Surra

South Africa is free from surra, thanks to the foresight of Sir Arnold Theiler. In 1906 the Transvaal Government decided to import a number of camels from Somaliland. Theiler met the consignment at Lourenco Marques. He bled the camels and injected the blood into rabbits and rats. The camels proved to be carriers of *Trypanosoma evansi* and were immediately slaughtered. This action certainly prevented a major disaster occurring in both Portuguese East Africa and the Union.

Dourine

It is not known when dourine was first introduced into the Union. The first diagnosis based on clinical symptoms was made by Andrews in 1916. The use of the complement fixation test showed that the infection was widespread and especially serious in the north-western Cape. A policy of testing all mares and entire males and slaughtering all reactors was adopted and the infection has been eliminated from most of the country although cases still occur in the remote parts of the north-western areas. The campaign is continuing and all horses intended for export must be tested.

Bacterial Diseases

Botulism (*Lamsiekte*)

Lamsiekte, which can best be translated as " paralysis disease ", was well known before Theiler came to South Africa and was the cause of very serious cattle losses, especially in the north-western Cape. As its name implies the disease manifests itself as a muscular paralysis. Hutcheon came to the conclusion that the cause was a phosphorus deficiency and bone meal feeding was known to reduce the losses, yet this hypothesis did not explain all the facts.

Theiler conducted numerous experiments at Onderstepoort and proved that it was not an infectious disease, or a vitamin deficiency, nor was it connected directly with the soil. (Over 100 tons of soil were transported from one part of the country to another to prove this latter point.) The possibility of the disease being caused by a plant poison was thoroughly investigated and over 60 different plants were tested, with negative results.

Early in 1918 Theiler took up a special assignment as Director of Lamsiekte Research at the government farm " Armoedsvlakte " near Vryburg in the north-west Cape. The name " Armoedsvlakte " means " poverty flats " and the farm was so named because of the exceedingly high incidence of fatal lamsiekte.

Theiler soon noticed that the cattle on the farm showed marked signs of pica or depraved appetite, and were particularly prone to chew old bones and even carrion. He had bones collected from the veld (at that stage this presented no difficulty) and allowed a group of cattle to eat them. Very soon cases of typical lamsiekte appeared. The way for organised research was open. Robinson examined the toxic bones and found them to be infected with botulinus organisms which produce a toxin causing muscular paralysis by damaging the neuro-muscular endplates. Green analysed the soil, pasture and blood of cattle from lamsiekte areas and found them all low in phosphorus. Discovery of the chain of events leading to lamsiekte was now complete: The soil was deficient in phosphorus resulting in a similar deficiency in the grazing; the consequent phosphorus deficiency in the animals led to a depraved appetite, resulting in the consumption of rotten bones which were frequently infected with botulinus organisms; and the toxin produced by these organisms caused the disease lamsiekte. Theiler therefore advocated the clearing of all farms of carcass material and the feeding of sterilized bone meal to prevent pica. This discovery was hailed with delight and parliament voted a special honorarium to Theiler as a mark of the country's appreciation.

It soon became apparent that the feeding of bone meal not only reduced pica and hence losses from lamsiekte, but also caused spectacular increases in growth rate and milk production. This led to a series of experiments on the whole question of phosphorus deficiency and supplementation, which are described under the heading " Phosphorus Deficiency ". (See page 639).

The effect of phosphate supplementation at Armoedsvlakte. Both Sussex steers are 3 years and 5 months old. The animal on the left received bone meal and weighed 1,425 lb. when the photograph was taken. The other animal did not receive bone meal and weighed 691 lb. Both were reared on the veld.

Despite attempts to keep farms clear of carcass material and the feeding of bone meal, losses from lamsiekte continued, though on a much reduced scale. Many animals show a low grade pica despite bone meal feeding and it is impossible to keep large farms entirely free of carcasses, which may include those of hares, tortoises, etc.

During subsequent experiments on the effect of phosphate supplementation, it was essential to keep control groups not receiving phosphate for comparison. Because of the unavoidable presence of toxic material and because they showed a high degree of pica, these animals were frequently lost as a result of lamsiekte. Mainly to overcome this difficulty workers at Onderstepoort produced a vaccine (formol-toxoid) against lamsiekte in 1931. By 1938 this vaccine had been proved to be effective and work was started to improve methods of production with a view to its issue on a large scale. This matter soon became extremely urgent, as, with the advent of the second world war, bone meal was in very short supply and all the ground gained was being lost.

In the original work, the botulinus organism isolated by Robinson was found to differ from those known up to that time, i.e. types A, B and C. It was designated " Type D ". Later it was found that type C occurred in South Africa and also caused lamsiekte. Toxoid from both types is now included in the vaccine.

The early vaccine was prepared by growing each type of organism separately in conventional meat broth and then preparing a formol-toxoid. These were then mixed to form the final vaccine. In 1950 a method was introduced which greatly increased the yield of toxin and reduced the cost of production. This consisted of placing the organisms, in normal saline, in a cellophane sausage case which was invaginated to increase the surface area relative to the volume. The sausage case was then immersed in the medium and nutrients diffused into the casing where the toxin was produced. Being of large molecular size, the toxin could not diffuse out from the casing where it accumulated to very high concentration, uncontaminated by protein from the medium. Further improvements included the development of a very economical medium consisting largely of corn steep liquor and the adsorption of the toxoid onto alluminium phosphate. Over three million doses of lamsiekte vaccine are now issued annually.

Anthrax

Anthrax is known to have occurred in South Africa since the days of Livingstone and was very widespread in certain areas at the time of Union (1910). Although the preparation of a Pasteur-type vaccine was undertaken at the Veterinary Laboratory, Grahamstown, during 1897, it was discontinued after the South African War. Until 1914, when the manufacture of anthrax vaccine was commenced at the Onderstepoort Laboratories, the vaccines used weie imported.

The first vaccine produced at Onderstepoort consisted of a suspension of *B. anthracis* attenuated according to the method of Pasteur. This was used with variable and often disappointing results. During 1920 a spore vaccine was developed in which the organisms were allowed to sporulate before they were suspended in a mixture of glycerine and saline. The strains employed did not differ in virulence from the ones used up to that time. A material improvement was effected, however, when a strain which had a virulence intermediate between the two recognised Pasteur types was used in the spore vaccine. Cattle and sheep were vaccinated successfully but losses were encountered in goats because of their greater susceptibility. Excessive swellings often appeared in horses after vaccination. A separate vaccine from organisms that had undergone further attenuation was prepared for horses and goats.

General view of Onderstepoort and environs.

This type of vaccine reduced the incidence of anthrax in South Africa and was used until 1937, when it was changed fundamentally by Sterne. He showed that virulent anthrax strains, incubated on 50 per cent serum agar in an atmosphere of 10 to 30 per cent carbon dioxide, may give rise to permanently non-capsulated variants which are avirulent. Non-capsulated strains with satisfactory immunogenicity were selected. A medium consisting of yeast extract-casein-hydrolysate-agar was developed. This promoted luxuriant growth and a high percentage of sporulation. The spores, washed from the surface of the agar medium, were suspended in glycerine saline containing a small percentage of saponin. The latter ingredient incited a local inflammation at the injection site which allowed local multiplication of the organisms after germination of the spores, thus improving the efficacy of the vaccine.

The advantages of the avirulent spore vaccine are as follows:—

1. It can be used on all types of domestic animals.
2. Its protective value can be determined in guinea-pigs.
3. It can be administered in small doses.

Since employing this vaccine, which was developed at Onderstepoort, anthrax has been under complete control in South Africa. In many areas regular annual inoculation of all cattle is compulsory.

Anthrax vaccine produced by the method developed at Onderstepoort is used practically throughout the world to-day.

Blackquarter

Blackquarter is known to have been one of the most prevalent diseases in bovines in South Africa since the time of the earliest European settlement at the Cape. During the latter half of the last century attempts were made to combat the disease by the importation of a so-called " powder vaccine ". After 1887 this same type of vaccine was prepared at Grahamstown and later in Natal and the Transvaal, but, soon after Union, all preparation of blackquarter vaccines was concentrated at Onderstepoort.

The first vaccine was made from powdered infected muscle. This product, similar to the imported one, had many shortcomings, but was nevertheless extensively employed in the Union, as is shown by the issue of over half a million doses during the year 1920.

During 1921 the possibility of the application of natural aggressins as an immunizing agent was investigated at Onderstepoort. This was prepared by filtration of the oedematous fluid and muscle juice obtained from artificially infected calves. Although it was a fairly satisfactory antigen, its preparation was abandoned largely on humane grounds.

Following favourable reports on the use of artificial aggressins, research was undertaken at Onderstepoort with a view to producing a vaccine by cultural methods. An artificial aggressin consists of a liquid bacterial culture freed from organisms by filtration. On copying the methods of overseas workers variable results were obtained but, after systematic improvements in the culture medium and method of cultivation, a product with superior immunizing qualities was produced. This was completely safe and had the advantages of simplicity of preparation and cheapness. It was issued for use in practice from 1922.

During 1929 the immunizing power of formalinized cultures of *Cl. chauvoei* and artificial aggressins were compared. The formalinized product was found to be more effective and easier and cheaper to prepare. A further improvement was effected by the addition of alum to the formalin-killed cultures, resulting in a vaccine giving complete protection for periods of up to 15 months. This vaccine is used on a large scale at present, as shown by the annual issue of over three million doses.

Lamb dysentery

Sufficient evidence exists to show that lamb dysentery has been responsible for heavy losses in the main sheep-farming areas of South Africa for the past sixty years. Very little progress was made with this problem except for a few successful transmission experiments in the early twenties. During 1935 Onderstepoort investigators proved that an organism isolated from an affected lamb was similar to *Cl. welchii* type B, which was responsible for lamb dysentery in Great Britain. Soon afterwards a vaccine against this infection was used with considerable success. The vaccine is administered to pregnant ewes which transmit a passive immunity to their lambs through the colostrum. Subsequent improvements in production techniques have enabled the dose to be reduced to only 2 ml. and the vaccine is giving excellent results.

Calf paratyphoid

Although it can be concluded from descriptions that paratyphoid has affected calves in South Africa since at least 1893, the aetiology of the disease was only elucidated at Onderstepoort in about 1928. From then onwards it was studied intensively and the fact established that over 95 per cent of the outbreaks were caused by *Salmonella dublin* and the rest by other types, viz. *S. enteritidis* and *S. typhimurium*. A vaccine was developed which was administered to calves. This gave fairly satisfactory results, but a remarkable advance was made when a vaccine was produced which could be administered to the pregnant cow, providing protection to the offspring via the maternal colostrum before vaccination of the calf itself could be effective. As a result of the use of this vaccine the incidence of paratyphoid in South Africa has been considerably reduced. Recently the effects of the new nitrofurazone derivatives have been tested.

Enterotoxaemia (pulpy kidney)

The presence of this disease among sheep in South Africa was only established in 1948 and it was soon found to be widespread. An alum precipitated formol toxoid prepared from cultures of *Clostridium welchii* type D has given excellent results and over 10 million doses of this vaccine are issued annually.

Brucellosis in cattle

Brucellosis in cattle (Contagious abortion) is a major problem in South Africa and is being actively tackled by the widespread application of calfhood vaccination.

It was clinically recognised more than 50 years ago and was diagnosed serologically in 1913.

Robinson, at Onderstepoort, did fundamental research on the nature of the infection in both cattle and guinea-pigs. It would appear that he was the first worker to succeed in eliminating the infection from a herd by regular testing and elimination of the reactors. This policy was successfully carried out on several government-owned herds, but proved too costly to be adopted by many private individuals. For many years work was confined to diagnostic tests and the preparation of a very limited amount of virulent vaccine to be used on non-pregnant animals in infected herds, as recommended by McFadyean and Stockman of England.

With the advent of the vaccine strain (" Strain 19 ") which was first isolated in America, the preparation of a non-virulent vaccine became possible. A further advance was the use of this vaccine in heifer calves—the so-called policy of calfhood vaccination. The strain was imported by Onderstepoort in 1934.

The post-war boom brought greatly increased demands for the vaccine and, despite all efforts, this demand could not be met by the standard agar culture method. A solution was found in aerated liquid culture methods, first successfully achieved by shake flasks and later adapted to the vortex aerated liquid culture technique. The present apparatus produces up to 200,000 doses per week and has eliminated the use of thousands of culture flasks. Although this method was not originated at Onderstepoort, great credit must go to workers here for the discovery of many improvements and the adaptation of the technique to suit local conditions.

To be effective, brucella vaccine must contain large numbers of viable organisms at the time of injection. The organisms tend to die out rapidly, and the long distances and hot weather frequently encountered in South Africa create special problems in ensuring that the vaccine used on remote farms is effective. For these reasons the vaccine is issued in freeze-dried form. The use of sodium-carboxy-methyl cellulose for concentrating and protecting the organisms permits the preparation of high dosage ampoules of convenient size for distribution.

Brucellosis in sheep

Recent investigations have shown that brucellosis in sheep is a serious problem in many parts of the Karroo. Not only does it cause abortion in ewes but it would appear to be a major cause of sterility in rams. Investigations are proceeding and the new *Brucella* vaccine strain, " Elberg. Rev. One " is being tested.

Toxicosis

Sweating sickness

Sweating sickness occurs in East, Central and Southern Africa. It causes severe losses in the Union, especially in the hotter parts such as the northern Transvaal, Zululand and the coastal areas of Natal. It is usually looked upon as a disease of calves, but adult cattle may be affected. Recently it has been shown that sheep, goats and pigs are also susceptible.

The popular term " Sweating Sickness " is derived from the most characteristic symptom: the calves appear to sweat profusely. Actually the fluid is due to a profuse wet eczema. This is accompanied by a high fever, hyperaemia and (frequently) ulceration of the visible mucous membranes, salivation, epistaxis, inappetence, diarrhoea and rapid loss of condition. Large scale outbreaks usually occur in the late summer but isolated cases may appear throughout the year in the hotter areas.

Everything pointed to the disease being infectious and transmitted by an arthropod, but as early as 1923 it was shown that it could not be transmitted artificially.

Ticks of the *Hyalomma* species (bontpoot or striped-legged ticks) had long been suspected of being connected with the condition. In this connection it is of interest to note that the Masai of Kenya use the same term for the tick and for the disease.

In 1953 two engorged bontpoot ticks (*Hyalomma truncatum* = *H. transiens*) were collected from infected calves in Zululand and sent to Onderstepoort. The progeny (larvae and nymphae) of these ticks were reared on rabbits, and the ensuing adults were allowed to feed on calves. The progeny of one of the ticks transmitted sweating sickness.

Subsequent investigation proved that the causal agent is not a virus but a toxin produced by certain strains of Hyalomma. During the next five years the progeny of ten successive generations were reared on rabbits and 20,000 adult ticks were available. It was found that members of the disease-producing strain of ticks continued to cause the disease over ten successive generations, irrespective of whether they were fed on susceptible, immune or insusceptible animals, such as the horse. Members of the non-disease producing strain could not be infected by feeding on affected animals. Recovered animals develop a solid immunity which persists for at least 18 months, but antibodies are not transmitted via the colostrum.

The riddle of sweating sickness was thus solved: some, but not all, strains of bontpoot ticks produce the causal toxin and the disease is not carried from one animal to another. Elimination of the tick is the only means of combating the disease.

Entomological problems

The blowfly problem

Until recently one of the gravest problems facing the sheep and wool industry was blowfly strike. South Africa and Australia faced much the same difficulties. The blowflies lay their eggs in the soiled wool of sheep, especially round the breech, and the resulting maggots cause festering wounds. In 1945 the position was so bad that many farmers were contemplating abandoning sheep breeding.

The main fly involved is *Lucilia cuprina*, the " green blowfly " which is responsible for 95 per cent of strikes in sheep. *Lucilia sericata*, the " European green blowfly ", plays only a minor role. Others involved are *Chrysomyia chloropyga*, the " coppertail blowfly ", and *C. albiceps*, the " banded blowfly ".

Early efforts to combat the fly with poisoned carcass material and by trapping proved fruitless. Later an effective remedy was evolved which was used to treat infected wounds and to destroy the larvae, but the labour of regularly treating thousands of sheep proved impracticable. Furthermore, this method failed to reduce the incidence of fly strike even when conscientiously applied over long periods. It was apparent that the only solution lay in the development of insecticides or repellents which would remain active on the sheep for a considerable time.

With the advent in 1946 of the chlorinated hydrocarbon insecticides such as DDT, new hope was born. DDT itself proved highly active against first stage larvae and showed some residual effect, but this did not last sufficiently long under field conditions to be of great value. As each new insecticide appeared it was tested. BHC showed a good residual effect in clean wool but was rapidly broken down in soiled wool. Dieldrin gave excellent results at first but resistant strains of flies developed in some areas. Finally diazinon was found to be highly effective, affording protection lasting up to eight months. The blowfly problem was virtually beaten.

Workers at Onderstepoort studied the mode of action of these insecticides and discovered that some of them had the property of diffusing along the wool fibre and penetrating into the new growth of wool, which explained the long protection afforded. They published techniques whereby the comparative value of various insecticides can be assessed in the laboratory.

Infectious itch of sheep (*Psorergates ovis* infection)

Since about 1950 complaints have been received from farmers with regard to an itchy condition in fine-woolled Merino sheep which caused the animals to scratch and rub themselves, thus damaging the fleece and reducing the economic value of the clip. Investigation proved the cause to be *Psorergates ovis*, a very small mite, and the parasite was found to be widespread in the Union.

The lesion produced is a low grade chronic dermatitis chiefly affecting the skin folds, which become thickened and show superficial desquamation of the epithelium which assumes a yellowish appearance.

The mite is found in four stages, viz. six-legged larvae, two nymphal stages and adults, which show very limited powers of movement. The life history has not been worked out but infection probably takes place when newly shorn sheep are herded closely together.

It was further ascertained from farmers that the infection had been present for many years but had only become a serious problem since about 1950. Up to this time arsenical sulphur preparations, alone or with the addition of derris extracts, had been used to control external parasites of sheep. A few years prior to 1950 BHC dips had come into prominence and a large-scale switch-over took place.

Investigation showed that, whereas the arsenical dips were active against Psorergates, the BHC dips which contained the gamma isomer, were not, and the increase in the incidence of infectious itch could be attributed to the use of these BHC dips.

Laboratory tests revealed the surprising fact that, whereas only the gamma isomer of BHC was active against lice and keds, the delta isomer had a specific action against Psorergates. Furthermore, the gamma isomer was found to have an antagonistic action against the delta isomer in mixtures of the two. Attempts to produce an all-purpose dip led to the production of a preparation containing four parts of delta isomer to one of the gamma isomer, in which proportions the antagonistic effect is not marked. This preparation is giving excellent results against all the external parasites of sheep.

Sheep scab (*Psoroptes communis ovis* infection)

Prior to 1924 the control of sheep scab was carried out by a special " sheep and wool " division of the Department of Agriculture, but in that year this duty was taken over by the Veterinary Division. At that time sheep scab constituted a major threat to the industry and a large-scale intensive campaign was organised. A special staff was appointed and all sheep were inspected and dipped under government regulation, the prescribed dip being lime-sulphur. Failure to report the presence of scab was a criminal offence. By 1930 the disease had been eliminated from the Union but occasional outbreaks on the borders continued for some years due to introduction from neighbouring territories. Such outbreaks are now rare and are easily controlled by the newer insecticides, such as BHC.

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Sex Physiology

The first recorded work on the oestrous cycle of domestic animals in South Africa was carried out by Kupfer, who published his findings in 1928. Not only did he study the occurrence and duration of the cycle in Merino and Persian sheep, goats, horses, donkeys and cattle but he gave a detailed description of the sequel of ovarian changes during the cycle. His work remains a standard reference.

Since that time Onderstepoort workers have made many major contributions in the field of sex physiology, the foundation for much of the more recent work undoubtedly being laid by Quinlan and his collaborators. The effects of nutrition and environment on the sex function and fertility of sheep and cattle have been studied extensively. Observations have been made on the effects of general malnutrition, overfeeding, vitamin and mineral deficiencies, lack of sunlight and lack of exercise. An enormous amount of data on the normal cycles and seasonal variations in different breeds of cattle and the Merino sheep have been collected. Similar, though more restricted, studies were made on the horse. Recently a comprehensive study of the breeding problems in the Thoroughbred horse under Karoo conditions has been published. An intensive study of the sex physiology of the pig has also been made.

Numerous studies on the viability and migration of sperm in the female genital tract have been published.

The complete breeding records of the cattle at Armoedsvlakte have been collected over a period of 34 years. The data were obtained from an average of 400 females per year, comprising Afrikaner, Friesland, Red Poll and Sussex pure-bred and grade herds. Figures available include oestrous cycle, conception rates and numbers of services per conception, gestation periods and birth weights of calves. This is probably one of the most comprehensive sets of data available in this field.

In 1939 Cloete published a thesis on the prenatal growth of the foetus and the changes in the maternal genitalia during gestation in the Merino sheep. This is still the most comprehensive study on the subject available.

Functional sterility

In 1929 Quinlan published an important paper on sterility in cows based on a detailed study of 64 cases. This work includes a complete record of the animals' sex history and the pathology of the genitalia.

The work on the effect of phosphorus supplementation on the fertility of phosphorus deficient cattle has been referred to elsewhere (see phosphorus deficiency).

The effect of delayed breeding on the reproductive capacity of beef heifers formed the subject of another important study. It was found that the postponement of breeding up to the ages of from four to five-and-a-half years frequently resulted in sexual disturbances and sterility. A full study of the pathology of the genitalia and endocrine organs was made.

Infertility in mares caused by ovarian dysfunction has also been investigated extensively. It was found that anovular oestrus constitutes an important cause of functional sterility in horses.

A vast amount of work on sterility in male animals has been done, largely in connection with artificial insemination.

Vibriosis

Vibrio foetus was first identified as a cause of abortion in South Africa in 1931 and the infection was subsequently found to be widespread, but it was not until 1953 that the infection was incriminated as a cause of infertility and aberrations of the oestrous cycle. It has been shown that the infection is not only transmitted by coitus but also by contact, and the infection in the female may persist for three years or more. Virulence is subject to great variation. It is now thought that vibrio infection is concerned with the aetiology of the condition known as " contagious epididymitis and vaginitis " (q.v.).

Trichomoniasis

Trichomoniasis was first diagnosed in South Africa in 1937 and is now widespread. Recent experiments indicate that the infection does not persist in the female genital tract for more than seven months.

Contagious Epididymitis and Vaginitis

This syndrome in cattle, characterised by infertility, epididymitis in the male and vaginitis in the female, was first described in the Union in 1949. It soon became apparent that it was present in a large proportion of herds showing low fertility. The condition has been transmitted experimentally by the introduction of vaginal discharge from infected females into the genitalia of healthy animals, but all efforts to isolate the causal agent have so far failed. The disease has never been transmitted by filtrates of infected material, which indicates that it is not caused by a virus. Recent investigations have shown that *Vibrio foetus* is present in all fresh outbreaks, giving rise to the suspicion that this organism is associated with some other, as yet unidentified, factor in the aetiology of the disease.

Milk composition

Several studies have been made on the factors, other than infection, causing variations in milk composition. It was found that feeding rations low in minerals had no effect on the mineral content of the milk. In another experiment it was shown that a heavy concentrate ration did not affect the percentage of solids-not-fat, whereas large amounts of dry roughage and succulents tended to depress the solids-not-fat.

In 1947 the results of an extensive experiment on factors affecting the composition of milk secreted by dry apparently healthy udders were published. This work showed that variations in milk composition may be due to advancing age, stage of lactation, season and individuality.

Phosphorus Deficiency

As described elsewhere, Theiler and his co-workers discovered, during their investigations into the cause of botulism, that there was a generalized phosphorus deficiency in the north-west Cape. The feeding of bone meal was originally advocated to prevent pica and the consequent ingestion of toxic carcass material. It soon became apparent that, in addition to preventing pica, phosphorus supplementation had dramatic effects in increasing growth, fertility and production. Furthermore, a hitherto common condition known as " stywesiekte " (stiffsickness) no longer developed in the growing stock. This condition was later proved to be rickets, caused by the phosphorus deficiency.

With the marked reduction in losses from lamsiekte and the increased productivity of the cattle following bone meal feeding, farming in the north-west Cape was revolutionised. A previously poverty-stricken area became prosperous and to-day not only is the largest creamery in the Union situated at Vryburg, where the original work was done, but is today one of our major beef producing areas.

The question of phosphorus deficiency and its correction has been the subject of intensive study by Onderstepoort workers since Theiler's original discovery in 1920. This work has not only been of great value to the Union, but also to many other countries where a phosphorus deficiency was subsequently discovered. Most of the experiments were carried out on the farm Armoedsvlakte, near Vryburg, which was originally purchased for research on botulism.

By 1924 it had been shown that all types of cattle in the phosphorus deficient areas showed marked improvement when fed bone meal. For instance, in one year, calves fed bone meal gained 134 pounds more in weight than their unsupplemented controls, and supplemented cows produced 30 per cent more calves.

The investigations were then directed towards determining the minimum amount of bone meal, or other phosphatic supplement, which would prevent pica, and hence botulism, and give an optimum productive response. It was found that the amount of bone meal required to prevent pica was greater than that required for production. When other phosphatic supplements were used, e.g. dicalcium phosphate, the functional response was found to be in direct relationship to the phosphorus content, but the prevention of pica was not so effective. Rock phosphate and superphosphate were found to be unsuitable on account of their high fluorine content, and basic slag gave indifferent results, probably due to the low availability of the phosphate.

In 1930 a nation-wide chemical survey of natural pastures was launched. The primary object was to ascertain the extent of phosphorus deficiency, but other constituents were included. Thousands of samples taken at monthly intervals throughout the year were collected from all areas. The results were published in a series of articles, and maps showing the major deficiencies in the different seasons were prepared. The grassland pastures were found to be deficient in phosphorus, crude protein and, in certain areas, sodium for the winter period ranging from five to nine months of the year, depending on the area and the season. Bush pastures, such as the Karoo, showed no deficiency. Blood samples taken concurrently from cattle living only on natural pasture proved a close relationship between the inorganic phosphorus of the blood and the phosphorus content of the grazing.

With the advent of an effective vaccine against lamsiekte which was in free supply by 1942, the prevention of pica ceased to be of great importance and research could be confined to investigating methods of phosphorus supplementation which would give optimum functional response as cheaply as possible. The problem was extremely urgent at that time, as bone meal was in very short supply due to the war and other sources of phosphorus had to be sought.

Theiler and his co-workers first supplied bone meal to ranch cattle by using " a large number of small troughs in a kraal and allowing not more animals into the kraal at any time than the number of troughs." For experimental purposes this method was replaced by daily hand-dosing, the cattle being passed through a crush. This procedure proved to be surprisingly easy, for the cattle soon learned to pack into the crush with their heads all facing in one direction, nor did they resent being dosed.

The spoon-dosing method is still the most reliable and economical way of feeding bone meal, but requires adequate labour and is time-consuming. Furthermore, the daily congregating of cattle at the crush leads to veld trampling and erosion.

The minimal dose of bone meal required to give optimal response in various classes of cattle was determined only after a long series of experiments lasting many years and involving hundreds of animals. It was found that the daily requirements were as follows:—

Growing, *non-producing cattle*, subsequent to weaning require two ounces of bone meal (6 gm. available P) per day. This is as effective as 3 oz. per day, even during subaverage seasons. During better-than-average seasons as little as 1 oz. per day will maintain normal growth and development. It was also found that labour could be saved and trampling of the veld reduced by dosing non-producing animals a double supplement three times a week instead of a single dose six times. The response was the same.

In a large-scale experiment, using 400 *breeding cows and heifers*, the effect of feeding 3, 4 and 5 oz. bone meal per day was tested over a number of seasons. The results showed that the differential treatment did not affect the live weight of the animals, the calving percentages nor the birth or weaning weights of the calves, but it did affect milk yield and butter fat percentage. The results suggest that, although cows and heifers in calf do not require more than 3 oz. bone meal (9 gm. P) six days per week, lactating cows should be given 5 oz. bone meal (15 gm. P) six days per week for optimum production.

Although it was known that the phosphorus content of the pasture was at its lowest during the winter months, this did not necessarily indicate that a phosphate supplement during the winter was essential to non-producing cattle over two years old, as such animals seldom gain weight and often actually lose it during that season. Comparable groups of weaner steers were given bone meal throughout the year and only during the summer months from October to March, respectively. When slaughtered under test conditions at the age of 40 months there was little difference between the two groups and it was concluded that it was not economical to feed bone meal to non-producing cattle during the winter. This does not apply to pregnant or lactating females.

Investigations on both growing steers and breeding cows were conducted over a number of years to determine the efficacy and economy of feeding phosphates to cattle in the form of a bone meal-salt lick available *ad lid.* Comparable groups, dosed with bonemeal six days a week, acted as controls. The different treatment made no difference to growth rate and body weight, but over the years the " dosed " cows showed an average calving percentage of 76 as against 64 for the " lick " cows. The most important difference was the average consumption of bonemeal. Over three years the average weekly consumption of the " lick " steers was 27·3 oz., whereas the dosed steers gave the same response although they received only 12 oz. per week. Over six years the cows with free access to bone meal took an average of 39·6 oz. per week, whereas those that were dosed received only 30 oz. per week. At the current price of bone meal (£20 per short ton), the bone meal consumed by the " lick " steers cost 20s. 9d. per head per year as against 9s. 1d. for the dosed steers. In the case of the cows, the corresponding figures were 35s. 1d. and 26s. 7d., respectively.

Further experiments were then conducted to ascertain whether the amount of bone meal consumed could be regulated by the amount of salt added to it. Various ratios were tested and it was found that when a mixture of three bone meal to two salt was used the daily consumption of bone meal by steers was maintained at roughly 2 to 3 oz. per day. Of the 20 experimental steers 17 made constant and sufficient use of the lick, but the remaining three rarely came to the troughs, developed poorly and revealed a high degree of pica.

In the various " lick " tests it was noticed that bone meal consumption dropped rapidly after good rains with consequent improved pastures, and rose as rapidly when rains failed and pastures dried out.

The continued shortage and high price of bone meal has made it essential to find substitute phosphatic supplements. Superphosphate is readily available but could not be used because of its high fluorine content. Experiments at Onderstepoort showed that by boiling a concentrated solution of superphosphate a large proportion of the fluorine can be precipitated and the supernatant fluid forms a safe and one of the cheapest forms of phosphate for cattle. Various other forms of phosphatic materials have been tested and it has been found that, provided the phosphorus is present in the form of the ortho-salts of Ca and the alkali metals, the nutritive value of a phosphatic mineral is, for all practical purposes, given by its P content as determined chemically.

To-day large amounts of water-soluble phosphate, such as defluorinated superphosphate, are administered to cattle via the drinking water. Machines designed to add a fixed proportion of a concentrated phosphate solution to the drinking water are available. The difficulty is the enormous variation in water consumption between individual animals and from season to season. In a carefully controlled experiment where the phosphate concentration was adjusted to the water intake so as to ensure the correct phosphate intake, no difference was found between animals receiving phosphorus via the drinking water and those dosed an equivalent amount of bone meal. Such careful control is not usually practicable and the intake of phosphorus varies considerably, sometimes being wastefully high and at others below requirements. The solution would appear to be in devising an easy method whereby water intake can be measured and the concentration of phosphate adjusted accordingly. Nevertheless the administration of phosphorus by means of the drinking water has proved a tremendous boon, especially in the face of a continued shortage of bone meal.

Enzootic Icterus (Acute Haemolytic Jaundice of Sheep)

Enzootic icterus occurs as large-scale outbreaks in the Karoo during certain years. It also appears sporadically, usually in sheep recently moved from the Karoo. The disease appears to correspond with " toxaemic jaundice ", as described in Australia.

The condition was studied intensively during a major outbreak in 1958. Although no conclusions as to the basic cause of the condition have yet been reached, it would appear that excess copper is not a contributing factor. The high copper values found in the blood and liver are probably secondary to liver and kidney damage.

The present concept of the aetiology in general is that of a chronic, subclinical intoxication or conditioning of sheep kept on herbaceous grazing of poor nutritional quality, precipitated by stress, which may be non-specific, and resulting in chronic, sub-acute or the classical explosive haemolysis.

Photosensitivity

A disease among sheep, aptly named by the farmers " Geeldikkop " (yellow thick head), has been known since 1886. As the name implies, the disease is characterised by jaundice and swelling of the head and it assumed great economic importance, especially in the Karoo areas, early in the century. In 1918 Theiler produced the disease by feeding the plant *Tribulus terrestris* to sheep. Theiler described the condition, including icterus and liver damage, and indicated that exposure to sunlight played a part in the pathogenesis.

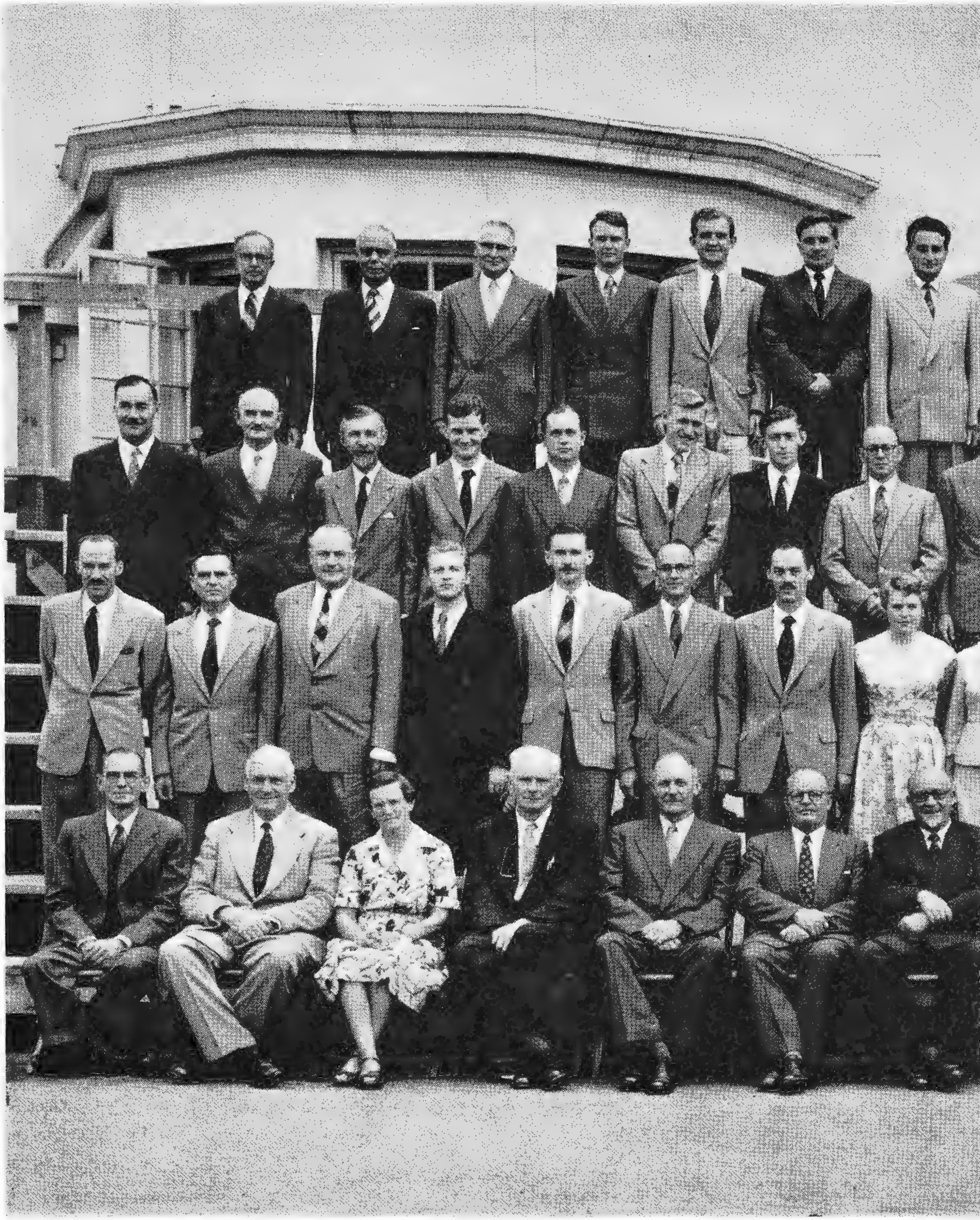
In 1928 Quin produced photosensitivity by the injection of photodynamic dyestuffs and proved that the liver damage was not a result of photosensitivity. He also showed that ligation of the bile duct in sheep not only caused icterus but also photosensitivity. From the blood of such sheep he and Rimington (1934) isolated the pigment, phylloerythrin, which was shown to cause photosensitivity when injected into normal sheep. The pathogenesis of this type of hepatogenic photosensitivity in ruminants was therefore established. Phylloerythrin is normally produced from chlorophyll by the ruminal bacteria, and is absorbed and excreted by the liver. Blockage of the excretory function of the liver could therefore produce both icterus and photosensitivity.

The active principle has not yet been isolated from *Tribulus*, but Quin and Rimington prepared similar acting principles from two other species, namely *Lippia* and *Lantana*. It was also shown that hepatogenic icterus is not always accompanied by photosensitivity, as when caused by carbon tetrachloride and phosphorus. Quin therefore concluded that bilirubin and phylloerythrin were excreted by different mediums.

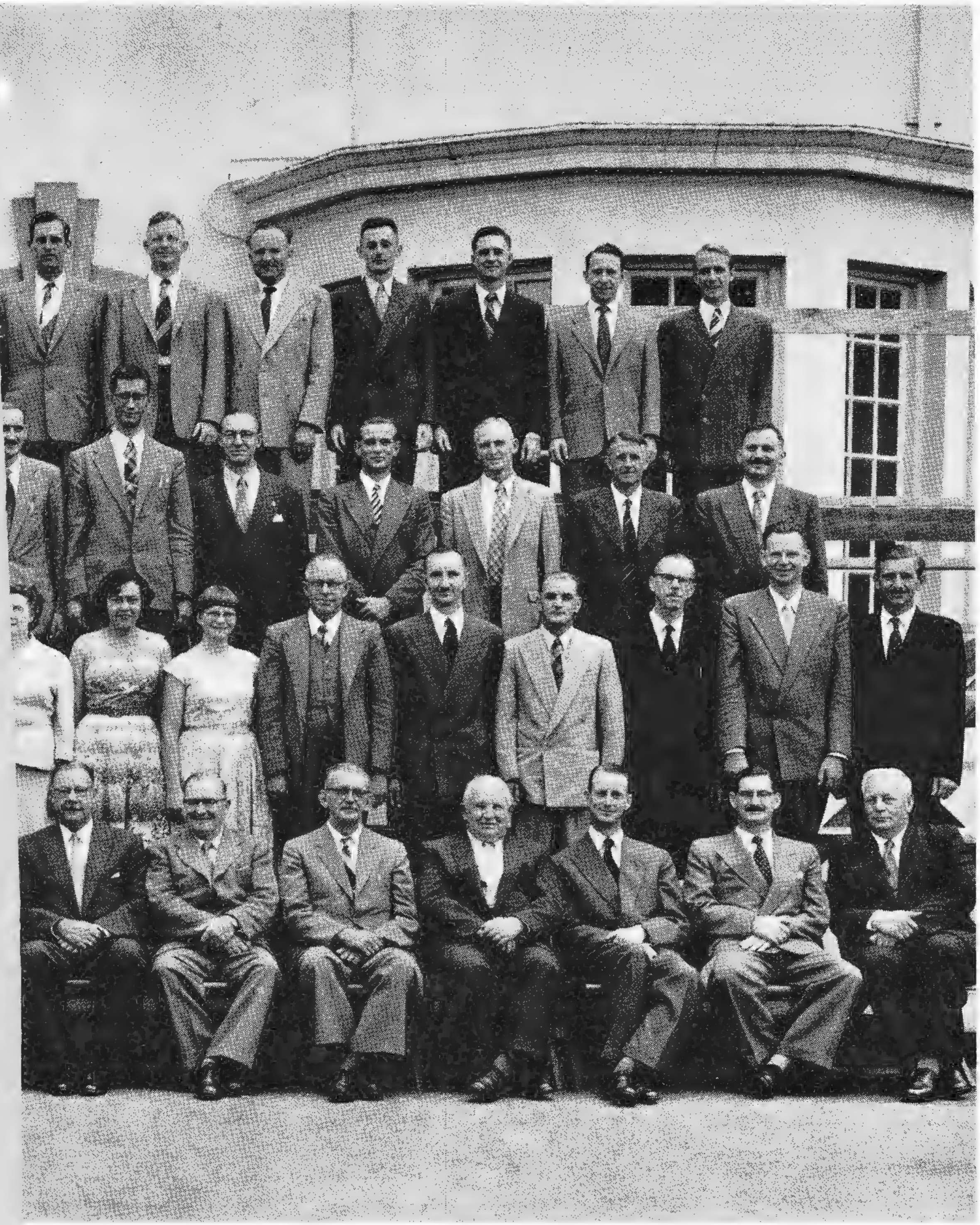
Since Quin's work, the majority of hepatogenous photosensitivities in ruminants have been proved to be due to phylloerythrin retention. In 1952 Clare dedicated his review, " Photosensitisation of Diseases of Domestic Animals ", to the memory of J. I. Quin, " pre-eminent worker in this subject ", a fitting tribute to a man whose work was cut short by his premature death in 1950.

The work on photosensitivity in general and geeldikkop in particular has continued, and, with the availability of better techniques, much progress is being made. Fundamental research into pigment metabolism and excretion in the sheep is being carried out.

A further big advancement has been made with the acquisition of a mobile laboratory. As already stated, the active principle of *Tribulus* has never been isolated, apparently because it only occurs in the plant under specific climatic conditions and for a very short time. Furthermore, it would appear to be very labile as the production of geeldikkop by feeding plants brought from the Karoo has never been successfully repeated since 1918. For these reasons field investigations using the mobile laboratory were carried out at the beginning of 1958 in the affected area. Preliminary plant extractions were carried out and natural cases were exhaustively examined. The results so far obtained promise considerable advancement in our knowledge of this complex subject.



Front Row (*Left to Right*):— R. Clark, J. D. W. A. Coles, G. Theiler, J. H. R. Bisschop, J. G. Louw, R. M
C. F. B. Hofmeyr, W. O. Neitz. *Second row*:— W. D. Malherbe, D. A. Haig, T. F. Adelaar, H. Kl
Verster, M. E. F. van Zyl, P. M. Bekker, J. D. Smit, K. E. Weiss, M. de Lange, G. C. van Drimmelen, K
Brown, G. S. Craig, J. de V. du Toit, J. A. Minnie, J. L. de B. van der Merwe, W. H. Gerneke, R. K. Loveday
son, R. J. Ortlepp, J. H. Kellerman, R. Bigalke, R. B. Cumming, R. J. Thomas, J. Procos, H. P. A. de B-



u Toit, H. Graf, R. A. Alexander (Director), A. M. Diesel, P. S. Snyman, J. G. Williams, B. C. Jansen, berg, R. C. Tustin, J. F. W. Grosskopf, J. M. W. le Roux, E. A. Rous, F. M. Gilchrist, A. J. M. van der Walt. *Third Row:*— N. Reinach, S. J. Myburgh, K. C. A. Schulz, A. Kistner, J. M. M. S. van Heerden, G. F. J. van Rensburg, G. D. Sutton, R. K. Reinecke. *Top Row:*— E. M. Robinm, J. H. Dreyer, D. R. Osterhoff, W. J. Serfontein, P. G. Howell, H. T. K. Weyland, D. H. G. Irwin.

Digestion and Metabolism in Ruminant Animals

Soon after 1930 Quin became interested in the physiology of the rumen and initiated a series of studies which are continuing to-day. The first of his series of papers, " Studies on the Alimentary Tract of the Merino Sheep in South Africa ", appeared in 1933. The last of this series (Number 23) appeared posthumously in 1951. The aspects of the subject investigated over this period include the mechanics of the forestomachs, ruminal microbiology and fermentation, bloat and the use of urea as a partial protein supplement to ruminants.

After Quin's death the work continued and was expanded by the formation of a special team engaged on fundamental research into ruminal microbiology. The main aspects being investigated are: the normal balance of functional groups of ruminal organisms and the disturbances of such a balance produced by changes of diet; the nature and proportions of the end-products of carbohydrate fermentation and the correlation between these end-products and the ruminal flora; the growth requirements of the cellulolytic bacteria; the aetiology of bloat and the synthesis of protein from urea nitrogen.

Meanwhile parallel work has continued in the section of physiology. Here an important study was made on the mechanics of the forestomachs, with particular reference to the eructation of gas and the pathogenesis of bloat. The metabolic fate of the volatile fatty acids produced in the rumen is also being studied, especially with regard to their role as precursors of glucose and ketones.