Paper No. 5.

RINDERPEST RESEARCH IN KENYA

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ACTIVE immunization against rinderpest, which is referred to in the text as the simultaneous inoculation, was first commenced in this Colony by Montgomery in 1910. Under the conditions which exist, viz., the occurrence of the disease in an endemic form in the native reserves and parts of the settled areas, the existence of susceptible game, viz., buffalo, eland, etc., which are a connecting link between the native endemic reserves and settled areas in the spread of the disease, and a factor in the maintenance of infection in both; the difficulty of controlling illicit movements of infected stock; the dissemination of the disease by susceptible vermin such as wart hog, wild pig, etc., and possibly by humans, particularly natives and carnivora, active immunization has so far proved to be the most satisfactory means of ensuring any permanent success in the control of the disease.

Rinderpest immunization in Kenya is carried out by a special service known as the Rinderpest Service, which operates at prearranged centres in the settled areas. A separate staff operates in some native reserves. The Honourable the Chief Veterinary Officer in his Annual Report for 1927 records that a total of 156,560 cattle (native and European) were simultaneously inoculated in that year and 194,306 in 1926.

Briefly, active immunization in Kenya consists of the subcutaneous inoculation of 2 c.c. citrated virulent blood and simultaneously a prescribed dose of anti-serum, viz., 20 c.c. per 100 kilos body weight for cattle of average susceptibility, which may be increased according to grade, susceptibility, field and climatic conditions, and condition of the cattle, on the recommendation of the veterinary officer in charge of the immunization operations.

Outbreaks are sometimes dealt with by serum alone, pending the carrying out of active immunization, when the herd is threatened owng to the existence of the disease in the vicinity or when rinderpest has already appeared in the herd, this method being generally known as the " serum alone." Animals under " serum alone " may contract rinderpest if in contact with infection, but are generally protected against a severe reaction and a serious mortality.

The method of serum production is as follows:—Susceptible high-grade cattle are immunized by the simultaneous method and when recovered hyperimmunized by intra-muscular injection of 5 c.c per kilo body weight virulent blood, and after a rest of eight days bled four litres weekly once a week for six weeks; after the sixth bleeding they are again hyperimmunized and bleeding continued as above; the sera of animals of different bleedings, i.e. 1, 2, 3, 4, 5, or 6 are mixed and a brew consists of four weekly bleedings. Approximately 200 head of serum-makers are maintained at the laboratory, and the production of serum amounts to approximately 30,000 doses monthly. New serum-makers are frequently added to the herd to replace animals

which, owing to various causes, have to be discontinued from serum-making. Each brew is tested on its potency on grade cattle at index doses of 15, 20, and 30 c.c. per 100 kilos body weight against 2 c.c. citrated fresh virulent blood, and should protect against a severe reaction and death. The test cattle are tested on their immunity on the fourteenth day after simultaneous inoculation, with 2 c.c. fresh citrated virulent blood.

The virus used for hyperimmunizing purposes is obtained from grade cattle of about 20 months old. These are infected by subcutaneous inoculation of 2 c.c. virulent blood and bled two or three times during the temperature reaction; at the final bleeding they are bled out.

As the result of active immunization being employed since 1910, the majority of adult stock in the settled areas are permanently immune, and it is now, generally speaking, only necessary to immunize the progeny, the custom being to immunize these after weaning. It is not compulsory for native owners in the native reserves to immunize their stock, but they are gradually realizing the advantages of this, and in some cases willingly submit their cattle for immunization.

During the past few years, problems have been investigated with a view to perfecting the method of native immunization which is made use of in the Colony; these included the following, viz.:—

(1) Conferring of immunity.

(2) The supply of virulent blood for field use.

(3) The production of virus free of redwater and anaplasmosis infections for simultaneous inoculation of regularly dipped cattle.

(4) Immunization of calves.

(5) Immunization of imported cattle.

(6) In addition, some obscure points met with in rinderpest immunization in the field have been cleared up and are referred to hereunder.

The experimental work and results obtained are recorded in the Annual Reports of the Chief Veterinary Research Officer, which are embodied in the Annual Report of the Department of Agriculture, Kenya Colony, for the years 1919-20 to 1928, inclusive, and in Bulletins No. 1 of 1921 and No. 4 of 1922, Department of Agriculture, Division of Veterinary Research.

(1) Conferring of Immunity.

Hitherto it was the custom to use citrated blood up till 24-30 hours after bleeding. Instances occurred where some susceptible cattle simultaneously inoculated with other than freshly collected blood, and the prescribed doses of anti-serum failed to react and either subsequently contracted rinderpest from contact with the reacting cattle of the herd with some mortality or escaped infection and remained susceptible.

In Kenya, animals simultaneously inoculated are entitled to the "A.M." brand, which signifies active immunity and which has a commercial value; hence it is imperative that an active immunity be conferred.

Investigations were carried out to determine the cause of non-reactions and non-conferring of immunity, and it was found that whereas the inoculation of citrated blood alone which had been bled 24, 30, or 40 hours previously from reacting virus-makers during the temperature reaction (usually on the third day of the reaction), and kept during the interval between bleeding and inoculation at ordinary temperature invariably produced a reaction; 24, 30-40 hours old blood of the same bleeding when inoculated with the prescribed doses of anti-serum sometimes failed to transmit rinderpest and confer immunity in susceptible cattle, but blood of the same bleeding when simultaneously inoculated immediately after being bled, with the prescribed dose of anti-serum, invariably set up rinderpest and conferred immunity. It was concluded that the use of fresh blood is a factor of fundamental importance in producing rinderpest in simultaneously inoculated cattle.

Blood kept for some hours at ordinary temperature becomes attenuated and the prescribed doses of serum inhibits the attenuated virus, and is a contributory factor in the cause of non-reactions. The variations in susceptibility of cattle is apparently another factor. In view of the above results, it was recommended that for field use, virulent blood should be used immediately after being bled and in any case not later than four hours; this was given effect to, and in addition the daily morning temperatures of some of each lot of the inoculated cattle are now recorded for several days after inoculation. Inoculated cattle are also injected six days after simultaneous inoculation with 2 c.c. fresh virulent blood.

The observations recorded hereon show that in susceptible cattle a reaction invariably occurs to simultaneous inoculation of fresh citrated virulent blood and the index doses of anti-serum used in the field, viz., approximately 20-35 c.c. per 100 kilos body weight and immunity is conferred. Although careful observations on a large number of highly susceptible cattle had previously shown that a high index dose of anti-serum, viz., 45 c.c. per 100 kilos body weight, and simultaneously fresh virulent blood did not " block out " the reaction or fail to confer immunity, it was recently found that a high index dose of anti-serum, viz., 45-75 c.c. per 100 kilos, sometimes failed to set up rinderpest or confer immunity in highly susceptible imported British cattle, simultaneously inoculated with fresh virulent blood or fresh nasal virus.

The effect of a large dose of anti-serum, viz., 250 c.c.; injected on the second day of the temperature reaction to South African bulls reacting to simultaneous inoculation of a large index dose of anti-serum, viz., 48, 60, 67, 74, and 80 c.c. per 100 kilos body weight (dose varied from 250-300 c.c.), and fresh nasal secretion virus, and in one case goat virus was apparent. The temperature reaction was curtailed. None were visibly sick. Four were subsequently tested on their immunity on the fifteenth day and one on the thirteenth day with fresh nasal virus. A temperature reaction with no other symptoms was recorded in three of the animals, and it was concluded that the original reaction was not sufficient to confer a complete immunity.

(2) The Supply of Virulent Blood for Field Use.

Hitherto the veterinary officer supervising immunization operations of dipped or undipped cattle selected the virus-maker, and infected it in the field either by contact with a naturally infected

animal or blood was issued from the laboratory to infect a beast, and where the latter was reacting the selected virus-maker was put in contact, the object being to reduce the risk of infecting the selected beast with redwater and gall-sickness; difficulties were frequently experienced owing to various causes such as non-susceptibility of some of the selected virus-makers; the delay which occurs in infecting by contact, viz., 10 or 14 days or thereabouts; the necessity of keeping the beast housed and under daily observation and recording the daily temperature and careful examination of blood-smears to exclude other infections and the impossibility of definitely fixing a date, until a day or two previous, for the simultaneous inoculation, and it was decided that the laboratory should arrange for the supply of all virulent blood required in the field. Owing to the distance of some of the inoculating centres from the laboratory, the blood could not be used within four hours after being bled and in such cases a susceptible beast is infected and railed the same day to the centre or transported by motor lorry.

The introduction of a method whereby all virulent blood required for use in the field could be supplied from the laboratory, and sucessfully used in the field, entered into consideration. If such were possible, the virus-maker could be kept under close observation at the laboratory and put on daily smear examination and bled when definitely known to be reacting to rinderpest; this would facilitate field operations considerably. Animals reacting to rinderpest are maintained at the laboratory throughout the year, and supplies of blood can be dispatched at short notice; only a limited number of cattle susceptible to redwater and anaplasmosis are available, and fewer would be used if they could be infected and bled at the laboratory, and the cost of production of virulent blood would be considerably reduced. It was decided to meet an urgent demand for " clean " blood for the simultaneous inoculation of dipped cattle, to issue blood packed on ice for use up till 24 hours after being bled. Some cattle had previously been experimentally inoculated at the laboratory with blood kept for 72 and 30 hours respectively at a temperature of approximately 0.4 degrees centigrade, and in the field with blood on ice issued from the laboratory and used up till approximately 28 hours after bleeding at a similar temperature, simultaneously with index doses of serum varying from 15-45 c.c. per 100 kilos.

To ensure the blood being kept at a low temperature, it was dispatched in insulated boxes containing a metal-lined chamber in which a metal holder for from two to six 250-c.c. bottles is fitted, and around which the ice is packed. Several thousand doses of blood on ice were issued for simultaneous inoculation of dipped cattle on several estates. The cattle were subsequently tested on their immunity, with the result that in once instance approximately 6 per cent. of the animals were found to be non-immune; on another estate, approximately 25 per cent. and in two other estates immunity had been conferred in all cases. The largest percentage of reactions occurred on immunity test, in cows in calf originally simultaneously inoculated with blood on ice used up till 24 hours and a high index dose of anti-serum, viz., 55 c.c. per 100 kilos body weight, the dosage amounting to 250 c.c. per head to avoid severe reactions and abortion. On the other estate in which reactions were obtained on

immunity test, the cattle were weaners, grades, and natives, and received a large index dose of serum, approximately 35 to 40 c.c. per 100 kilos.

In view of the above results, the issue of iced blood was discontinued, and the use of virus-makers infected at the laboratory and dispatched to the centre by rail or lorry substituted.

(3) The Production of Virus free of Redwater and Anaplasmosis for the Simultaneous Inoculation of Dipped Stock.

Blood obtained from a beast susceptible to redwater and anaplasmosis is referred to in the text as " clean blood " and virus free of redwater and anaplasmosis as " clean " virus.

In the early days of rinderpest immunization in this Colony, dipping of cattle was not resorted to, hence cattle submitted for rinderpest immunization were, generally speaking, recovered redwater and gallsickness beasts, and recovered animals were used for virus production. During the past few years, however, dipping has been introduced and is to-day fairly extensively employed, particularly for combating East Coast fever, with the result that a percentage of cattle now submitted for rinderpest immunization are susceptible to redwater and anaplasmosis. In anticipation of demands being made for " clean " blood or " clean " virus for dipped stock, various avenues were exploited with a view to the production of " clean " blood or " clean " virus, viz.:—

(*a*) The substitution of sheep blood for bovine blood (first passage of bovine virulent blood).

(*b*) The substitution of goat blood for bovine blood (first passage of bovine virulent blood).

(*c*) The substitution of peritoneal washings and filtrates of washings for bovine blood.

(*d*) The substitution of nasal secretion and filtrates of nasal secretion for bovine blood.

(*e*) The use of cattle born and reared on farms where dipping is regularly carried out.

(*f*) The breeding and rearing of cattle free of tick-borne disease.

(*a*) *The Substitution of Sheep Blood for Bovine Blood* (*First Passage of Bovine Virulent Blood*).

Merino sheep do not naturally contract rinderpest, but when inoculated with virulent bovine blood a slight temperature reaction usually occurs from about the fourth or fifth day after inoculation, but with little or no marked symptoms of rinderpest other than perhaps an increase of nasal secretion. Prior to the carrying out of experimental inoculations to determine whether sheep blood could be substituted for bovine blood for the supply of rinderpest virus free of redwater and anaplasmosis, the transmissability or otherwise of redwater and anaplasmosis to sheep and from sheep to susceptible bovines was investigated, with the following results, viz.:—

1. The inoculation of redwater and anaplasmosis blood of a bovine did not produce any visible effects and no reaction to either infection in the sheep.

2. The inoculation of calves susceptible to redwater and anaplasmosis with blood of sheep which had been inoculated with redwater and anaplasmosis blood of a bovine produced no visible effects and no reaction to either infection.
3. Calves which had been inoculated with blood of a sheep, which had been previously inoculated with redwater and anaplasmosis blood of a bovine, when reinoculated with bovine redwater-anaplasmosis blood, reacted to anaplasmosis and in some cases redwater. The transmission of anaplasmosis manifested itself in the occurrence of parasites with, in some cases, a well-marked temperature reaction.

The transmission of redwater was confirmed in some cases only by the detection of *P. bigeminum* parasites in blood-smears.

Inoculation of susceptible cattle with blood of reacting sheep produces rinderpest. Incidentally, the urine and faeces of a sheep whose blood was virulent did not transmit rinderpest, and sheep kept in contact with rinderpest reacting cattle did not contract the disease, and vice versa. Dosing sheep with virulent bovine blood produced a reaction to rinderpest in sheep.

Experimental inoculations to determine the value of sheep's blood resulted as follows:—

(i) (*a*) Blood alone of a reacting sheep exceptionally failed to produce rinderpest in susceptible cattle.

(ii) (*b*) Simultaneous inoculation of blood of a reacting sheep and anti-serum gave varying results; some reacted; in some instances delayed reactions; in other irregular reaction occurred with a mortality; other cattle did not react; the substitution of sheep blood for bovine blood was accordingly not recommended.

(*b*) *The Substitution of Goat Blood (First Passage of Bovine Virulent Blood).*

Experimental inoculations carried out at the laboratory by the writer and in the field by Dr. S. H. Whitworth, Veterinary Research Officer, gave similar results to those otbained with sheep blood, and it was concluded that blood of a reacting goat is unsuitable for virus for simultaneous inoculation of cattle. Investigations were subsequently commenced to determine whether the virulency could be exalted and fixed in goats by passage. 5 c.c. bovine blood was inoculated into the *os uteri* of goat No. 1 and when the animal was reacting, 5 c.c. of its blood collected, and inoculated intravenously into goat No. 2 and subinoculations through goats were made up till the seventeenth passage. Unfortunately, an outbreak of a specific lung affection, which resembles that described by Mohler and Washburn under the name "Takosis," occurred amongst the goats, which complicated and obscured the results, and the experiment had to be discontinued.

(*c*) *The Substitution of Peritoneal Washings or Filtrates of Peritoneal Washings for Bovine Virulent Blood.*

The method of obtaining peritoneal washings was as follows, viz., 5 litres of a 0.6 per cent. potassium nitrate solution in sterile tap-water was injected into the peritoneal cavity of a reacting virus-maker three hours before the animal was bled out and the washings collected after death in 0.5 per cent. citrate solution.

The peritoneal washings were usually found to contain some red cells, and attempts were made to free the washings of these by filtration through the Barkefeld and Seitz filters respectively. The filtrates were variably virulent, but the virus soon became attenuated. Neither method was considered to be of practical utility.

(d) The Use of Nasal Secretion of a Reacting Virus-maker.

Fresh nasal secretion may be successfully substituted for virulent bovine blood for infecting virus-makers susceptible to redwater and anaplasmosis. In some instances it has been successfully employed for the imultaneous inoculation of imported cattle susceptible to redwater and anaplasmosis; but, as already mentioned, in other imported cattle no reaction occurred and the cattle were subsequently proved susceptible.

The nasal secretion is collected from the reacting virus-maker on the second day of the temperature reaction by rubbing the nasal mucosa lightly with cotton-wool held by a pair of forceps. The cotton-wool is then inserted in a flask containing 50 c.c. of an 0.5 per cent. citrate solution. This process is repeated on two or three occasions, and 40 c.c. of the infected citrate solution injected subcutaneously.

Nasal secretion collected towards the latter end of the temperature reaction sometimes contains pathogenic organisms which, when inoculated, set up an infection which manifests itself as a yellow gelatinous infiltration of the subcutaneous tissue at the site of inoculation, and which extends therefrom and causes some mortality. This did not occur when the nasal secretion collected in the early stages (second day) of the temperature reaction was used.

J. R. Hudson, veterinary field officer, found that the infectivity of the nasal secretion when collected after the seventh day after inoculation could not be relied upon. Owing to the difficulty of obtaining large supplies of nasal virus and conserving the virulency "in vitro," its use in the field for simultaneous inoculation of a large number of cattle is not a practical proposition; in addition, the decrease in virulency is likely to be responsible for non-reactions and non-conferring of immunity in some cases. Hudson found that nasal discharge compares very badly with blood in the length of time for which it may be kept before inoculation. In no case, according to Hudson, has it been found to produce a reaction to rinderpest when kept for four hours after collection under field conditions. On the other hand, if drawn on the fifth to seventh day after inoculation, he always found it set up rinderpest up to two hours and in some cases 2½ hours after collection, and recommends that it be used as soon as possible and not relied upon after the elapse of 2½ hours.

When nasal secretion is obtained from an animal towards the end of the thermic reaction, or if collected on the fifth to seventh day, and kept towards the limit of its period of infectivity, an abnormal reaction is produced. This reaction is characterized by the fact that the temperature does not usually rise above 104 degrees Fahr., and usually remains elevated longer than usual. Frequently the disease takes the violent intestinal form.

The filtrates of fresh nasal secretion diluted in citrate and well shaken with glass beads before filtering through the Berkefeld and Seitz filtres were virulent, and when kept in the ice-chest for 24 hours in sealed tubes transmitted rinderpest, but when stored for eight days on ice in tubes plugged with cotton-wool were avirulent.

Owing to the variability of obtaining a virulent filtrate and the non-maintenance of the virulency and the variability of obtaining a reaction in simultaneously inoculated cattle, the use of nasal filtrate was not generally recommended for simultaneous inoculation.

Unsuccessful attempts were made to obtain a virulent Berkefeld and Seitz filtrate from diluted blood and from blood after haemolysing with distilled water. It was concluded that the virus does not exist free in the plasma or red cells; virulent filtrates may variably be obtained from citrated nasal secretion diluted and well shaken with beads prior to filtration, which supports the view that the virus does not exist in the red cells or plasma.

(e) The Utilization of Cattle Born and Reared on Farms where Dipping is regularly carried out.

Cattle, age about 12 months, were obtained from farms where dipping is regularly carried out from or shortly after birth either or not combined with hand-dressing and their blood inoculated into newly-born calves born and reared in tick-free stables. It was found (*a*) that a large percentage of the young stock (18-20 months old) born and reared on an estate where the cattle have a wide range of country and where dipping at seven-day intervals not combined with hand-dressing is in operation do not escape redwater and anaplasmosis; (*b*) a large percentage of young stock, age six months, regularly dipped at three-day intervals combined with hand-dressing, escape redwater and anaplasmosis; (*c*) a large percentage of young stock born and reared on an estate where three-day dipping is regularly carried out, *not* combined with hand-dressing, escape redwater and a smaller percentage anaplasmosis.

Discussion.

On certain farms, particularly in the drier parts of the Colony, three-day dipping from or shortly after birth with or without hand-dressing decreases the incidence of redwater and anaplasmosis. The common carriers, viz., *Boophilus decoloratus* and *B. australis*, are dipped out, but not the exceptional carriers (the brown ticks and red-legged ticks), which, it would appear, owing to the low incidence of the disease consequent upon dipping, are, generally speaking, not infected. The brown ticks and red-legged ticks maintain infection on farms, where *seven days' dipping not combined with hand-dressing is in operation.*

Susceptible newly-born calves reared on their mothers do not in all cases give a definite reaction to redwater and anaplasmosis when inoculated with 5 c.c. blood of a recovered beast, and in such cases parasites do not occur in the peripheral circulation, or are rare, and may escape other than careful microscopical examination of smears. This method of determining whether a selected virus-maker is susceptible or otherwise to redwater and anaplasmosis is, therefore, not infallible, but as a temporary measure until calves reared in tick-free stables are available, blood of virus-makers, tested as above, is being used in the practice for immunization of a large number of dipped stock, with satisfactory results.

Incidentally, the testing of blood on newly-born calves reared on their mothers has demonstrated that the former, when inoculated with blood of a recovered redwater-anaplasmosis beast, does not produce a severe reaction to either, and that the inoculation of calves

born and reared under ranching conditions immediately after birth may be resorted to as a means of immunizing the calves on farms where dipping is carried out, and it is not considered desirable to rear susceptible redwater-anaplasmosis cattle.

(f) The Breeding and Rearing of Virus-makers free of Tick-borne Diseases.

It was decided to adopt this method of producing "clean" blood; the procedure is as follows, viz., the laboratory maintains a herd of breeding stock, the mothers are freed of ticks by dipping and hand-dressing a week or so before calving and then placed in loose boxes in tick-free stables. The calves are thus born under tick-free conditions, the mothers and calves occupying the same loose box until the calf is ready for weaning, usually six months after birth. The mother is then turned out to the breeding herd and the calf remains in the tick-free stable until of a suitable age for rinderpest virus production (nine months upwards). When "clean" blood is required in the field, a tick-free reared beast is subcutaneously inoculated with nasal secretion collected on the second day of the temperature reaction from a reaction virus-maker, and railed or transported to a centre where the animal is bled on different occasions during the temperature reaction.

4. Immunization of Calves.

Laboratory experimental inoculations showed that a percentage of unweaned grade calves (the progeny of immune mothers) which had not been in contact with rinderpest from birth react to inoculation of virulent blood alone, with a percentage of mortality; others give a temperature reaction with no clinical symptoms; others an irregular temperature reaction only and a percentage do not react. Careful observations were made on twenty calves, inoculated each with 5 c.c. of virulent blood only, the results were as follows, viz.:—

15 per cent. reacted and died.
20 per cent. reacted and recovered.
10 per cent. gave a doubtful reaction.
55 per cent. gave no reaction.

Of seven unweaned calves, the progeny of *highly susceptible* mothers inoculated with 5 c.c. fresh virulent blood alone, 85 per cent. died of rinderpest, in some cases complicated with redwater.

Simultaneous inoculation of unweaned calves, varying in age from seven weeks to nine months (the progeny of immune mothers) which had not been in contact with rinderpest since birth, with fresh virulent blood and anti-serum at varying index doses, viz., 15, 30, and 45 c.c. per 100 kilos body weight, gave the following results:—

33 per cent. gave a temperature reaction.
33 per cent. gave a doubtful reaction.
33 per cent. gave no reaction.

No mortality occurred.

When tested on their immunity on the fourteenth day, none reacted and when tested on their immunity approximately two months later none reacted. They were not tested on their immunity after weaning.

An experimental inoculation of 102 unweaned grade calves, the progeny of immune mothers, was carried out by Veterinary Research

Officer Dr. S. H. Whitworth. Fresh virulent blood and anti-serum at the rate of 25 c.c. per 100 kilos body weight was used and results carefully recorded. 74.5 per cent. reacted; 25.5 per cent. did not react.

In another carefully controlled field experiment, 30 grade calves (progeny of immune mothers), ranging in age from a month to six months, were inoculated with 27-hours-old blood and anti-serum at the rate of 15 c.c. per 100 kilos body weight, and another lot of 30 with 27-hour-old blood and anti-serum at the rate of 30 c.c. per 100 kilos body weight.

The result was:—

33.3 per cent. of the 15 c.c. lot reacted with 7.5 mortality.
33.3 per cent. of the 30 c.c. lot reacted with no mortality.

Immunity test of Weaned Calves which had been Inoculated before Weaning (from 1-6 months).

Twenty-seven-hours-old blood and anti-serum at the rate of 30 c.c. per 100 kilos was used; 12 were put on experiment; of these 66 per cent. reacted with no mortality to rinderpest, and 33 per cent. did not react. On a subsequent immunity test none reacted.

DISCUSSION.

Owing to the natural resistance which some calves possess and is apparently acquired from the milk of immune mothers, there is no satisfactory method of actively immunizing calves until after weaning, and it is the custom not to immune brand unweaned calves which have been simultaneously inoculated. When an outbreak occurs in a herd which includes breeding stock and calves, and the herd is simultaneously inoculated and the mothers are susceptible, a mortality is likely to occur in young calves, but simultaneous inoculation of calves (progeny of immune mothers), being reared under ranching conditions, should not produce any serious mortality. Young calves, the progeny of susceptible mothers being less resistant, a larger percentage react to rinderpest in comparison with calves born of immune mothers, even if the calves be kept under serum, some are likely to contract rinderpest by contact with reacting mothers. The digestive disturbances consequent on the reaction, and the diminution of the milk supply would appear to be factors responsible for the losses which are sometimes experienced in calves.

Calves are responsible for the maintenance of infection; if serum alone be inoculated, a percentage contract rinderpest from the reacting animals by contact, others escape infection, but subsequently become infected, and some of the newly-born calves may contract the disease from the reacting calves. As stated above, game are also a factor in maintaining infection on estates where such exists. Serious losses have been reported in young calves reared under dairy conditions consequent on simultaneous inoculation. In such, the resistance to disease is low and they are often not in a suitable condition to be simultaneously inoculated. It is the custom to keep such under serum until all trace of the disease has disappeared, but this is usually a costly method owing to the necessity of continuing inoculation at fourteen-day intervals.

On some dairy estates, a herd of pure-bred stock is maintained which it is not the custom to actively immunize; hence, where the disease is being maintained by calves or game, the pure-bred stock are exposed to infection. In such cases, the pure-bred stock are kept