Cattle Tick (Boophilus microplus)—Its occurrence and attempted eradication in the Territory of Papua and New Guinea

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Introduction.

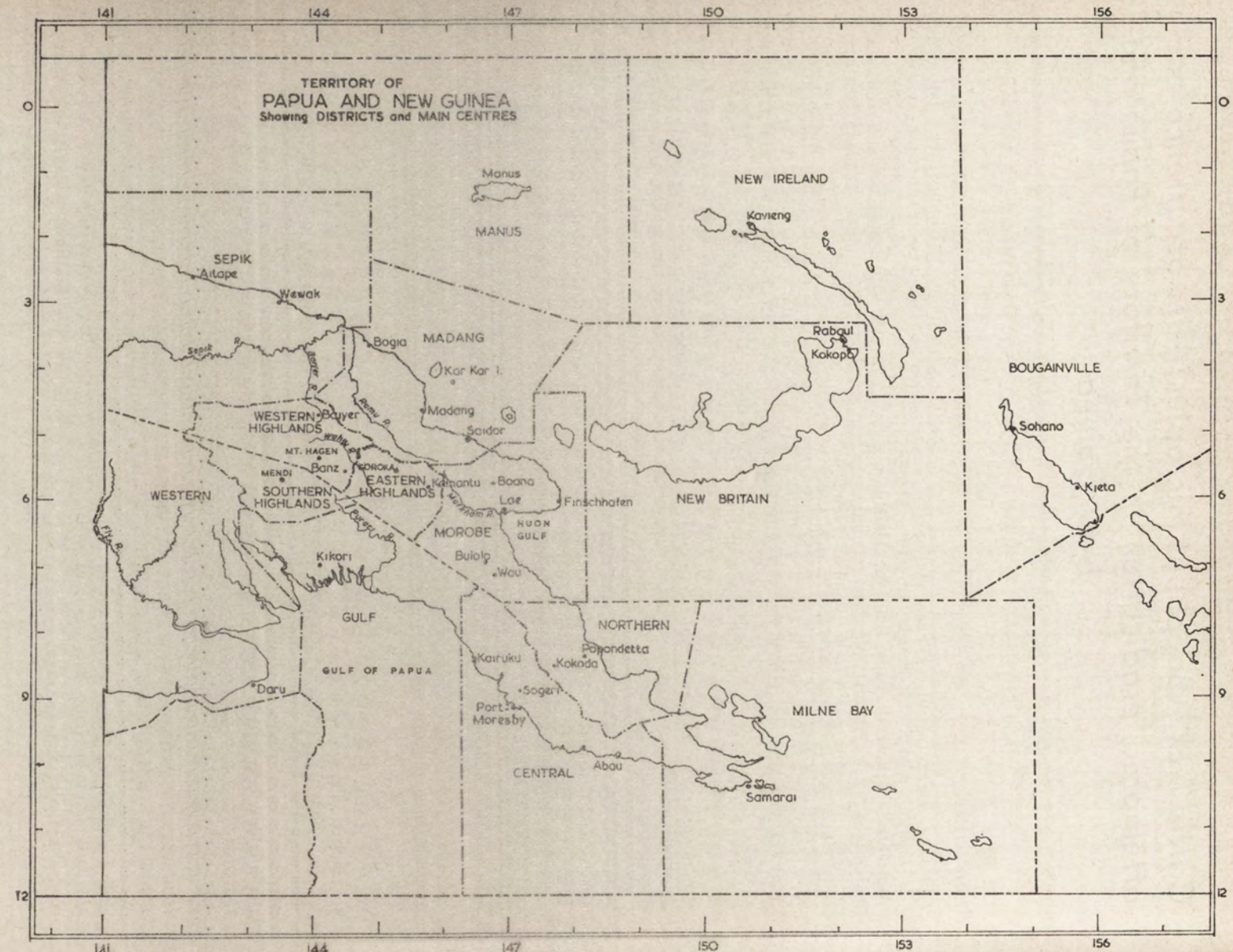
THE Territory of Papua and New Guinea, which is made up of the Australian Territory of Papua and the United Nations Trust Territory of New Guinea, includes the eastern part of the island of New Guinea and the large islands of New Britain, New Ireland and Bougainville, together with many smaller islands adjacent to them. The map (Figure 1) shows the division of the Territory into its districts and the centres of administration of these districts. The whole Territory is administered by Australia with headquarters at Port Moresby. The districts will be mentioned later in locating the eradication programmes. The Territory lies wholly within the inner tropics and is typical of the wet humid tropics. Most places in the Territory experience an annual rainfall in excess of 80 inches. The central mountain ranges reach heights of over 15,000 feet in many places and include some of the world's most rugged country.

Cattle Tick (*Boophilus microplus*) was probably brought into the Territory with the original introductions of Zebu type cattle from the then Dutch East Indies, prior to World War I. Cattle from this source were brought to Southern Papua and to many parts of New Guinea when it was a German colony. Following the establishment of the Australian Mandate over New Guinea in 1918, importations of cattle were made from Queensland. These importations added to the cattle tick infestation because there was little or no control over them. The parasite was recorded as a serious pest of cattle in the Rabaul area just prior to the hostilities of World War II. Hutchinson (1942) and early residents can recall infestation in almost all parts of Papua and New Guinea where cattle were grazed.

Most of these pre-war cattle were on the coastal plantations. During the Japanese occupation the herds were driven away from their normal grazing areas and the cattle tick was distributed with them. Cattle on the north coast of New Guinea (Madang District) were driven inland across ranges of mountains to the Central Highlands where the Japanese advance did not penetrate. Several small groups were left behind along the route of the drove when they could not keep up with the main herd, and became wild. The influence of the Zebu types from these groups can still be seen in some parts of the Highlands. All of the groups have since been absorbed into herds under control or have been slaughtered. Cattle tick was distributed by this movement over the area which has the greatest potential for cattle raising in Papua and New Guinea.

The population of cattle immediately pre-war was given as 20,494 in the Territory of New Guinea and 5,994 in Papua—a total of 26,488 for what is now the Territory of Papua and New Guinea. The cattle population in both Territories immediately post-war was estimated at 2,500, so that the majority of the Territory's cattle had been destroyed and the cattle industry was forced to recommence from almost nothing. Cattle that did remain provided the reservoir of cattle tick which reinfested the cattle imported post-war to build up the Territory herds.

The first survey of Animal Health in the Territory was carried out in 1946 by 1 Australian Mobile Veterinary Survey Unit of the Australian Army. The report of this survey shows a distribution of cattle tick which parallels the reported distribution pre-war, except that in several areas cattle were not sighted because they had been driven into the bush by the hostilities. Cattle tick were


TERRITORY OF
PAPUA AND NEW GUINEA
Showing DISTRICTS and MAIN CENTRES
141
144
147
150
153
156
0
3
6
9
12
Manus
MANUS
NEW IRELAND
Kavieng
SEPIK
Ambunti
Wewak
Sepik R.
Bogia
MADANG
Kar Kar I.
Madang
Saidor
Rabaul
Kokopo
BOUGAINVILLE
Sohano
Kieta
WESTERN HIGHLANDS
Ramu R.
Wahgi R.
MT. HAGEN
Banz
MENDI
SOUTHERN HIGHLANDS
EASTERN HIGHLANDS
Kainantu
Goroka
Lae
Finschhafen
NEW BRITAIN
WESTERN
Fly R.
Purari R.
Markham R.
MOROBE
HUON GULF
Bulolo
Wau
Kikori
GULF
GULF OF PAPUA
Daru
NORTHERN
Popondetta
Kokoda
Kairuku
Sogeri
Port Moresby
MILNE BAY
CENTRAL
Abau
Samarai

recorded from cattle in the Central and Milne Bay Districts of Papua, and in the Morobe, Eastern Highlands and Western Highlands Districts of New Guinea. The report also recorded that ticks were first introduced into the Eastern Highlands District with mission owned cattle in 1933, and in 1937 to the Western Highlands District, although more ticks undoubtedly came into the area with the cattle evacuated from Madang.

Cattle tick were recorded by Hutchinson (1942) on cattle on the Gazelle Peninsula, but there were no hosts available at the time of the Army Survey. Similarly, no hosts were available for inspection in the Madang and Sepik Districts.

Blood smears were taken from cattle in many areas where cattle ticks were recorded, but in no case was evidence found of the protozoan diseases collectively known as tick fever. In five cases from the Milne Bay District *Theileria mutans* was recorded but it is of no pathological significance.

Post-war Developments.

Veterinary Services were established within the Department of Agriculture, Stock and Fisheries following the resumption of normal civil administration. The first Chief of the Division of Animal Industry, Mr. W. Granger, recognized the value of having a cattle industry without cattle ticks and cattle tick fever, and his early efforts were directed towards the confinement of infested cattle, together with the importation of tick free cattle to areas which were not infested.

During the period 1947-1950 surveys of cattle tick and cattle tick fever were carried out by officers of the Division of Animal Industry. Clinical diagnoses of cattle tick fever were made at Aiyura, Western Highlands District in November, 1947, Port Moresby, Central District in January, 1948, Goroka, Eastern Highlands District in February, 1948, Mount Hagen, Western Highlands District in August, 1949, Abau, Central District in September, 1949, and Kainantu, Eastern Highlands District in April, 1950. The outbreaks at Port Moresby, Goroka and Mount Hagen were confirmed by blood examination and the identification of *Babesia bigemina*.

Cattle tick were found to have spread considerably since the Army survey, and could be found at all places in the Eastern and Western Highlands where cattle were grazed; in the Morobe District, in the Lae, Boana, Wau, Zenag and Finschhafen areas; in the Madang District near Madang, Bogia, Saidor and on Kar Kar Island. They were found on wild cattle on the Gazelle Peninsula and on Southern New Ireland, and moved into newly imported cattle in the Kokopo and Rabaul areas. They were also noted on the few remaining animals in the Bougainville District.

Measures to control the infestations were instituted on all Administration stations, and other owners of cattle were advised on control measures. Movement of cattle and horses was restricted, and animals were subjected to spraying treatments. Legislation for the control of animal movement did not exist at this time, and this, together with the lack of veterinary and stock inspection staff, mitigated against successful restriction of the spread of cattle tick.

With the precedent of the United States eradication programme and the advent of newer, less toxic acaricides, the progressive eradication of cattle tick from the Territory was proposed by Granger, and a scheme of voluntary eradication was formulated by the Parasitologist of the Division of Animal Industry, Miss O. Macpherson, in 1950. The voluntary eradication agreement was to be drawn up along the following lines:—

> The Department of Agriculture, Stock and Fisheries would make available the services of an experienced officer and the necessary equipment for the purpose of eradicating cattle tick on selected properties or in certain areas, provided that the owners of stock on these properties or in these areas agree to carry out any measures considered necessary by the Department for the eradication of tick in accordance with the instructions and under the supervision of an officer of the Department.
>
> Any equipment, including tickicides, will remain at all times the property of the Department.
>
> The owner may be required to keep such records relating to the eradication work

being carried out on his property as may be deemed necessary by the Department.

The decision as to when eradication is complete and when spraying may be discontinued will rest with the Department.

The Department reserves the right to discontinue the free provision of equipment and the services of its officers at any time.

Approval for the implementation of the scheme was given by the Administrator of the Territory on 18th April, 1950, provided that it was made clear to the owners of cattle that the voluntary scheme did not replace a compulsory scheme under Ordinance at a later date, which was considered necessary for complete eradication.

Such a scheme, however, did serve a very useful purpose as a trial for the future compulsory eradication. Field observations were made on the comparative efficiency and suitability of newer insecticides under tropical conditions, and several observations carried out during some of the voluntary eradications influenced future policy decisions with regard to the compulsory scheme.

The voluntary scheme was commenced in the Morobe District on Lutheran Mission, Malahang, Lutheran Mission, Boana, and in the Western and Eastern Highlands, at various mission stations and Government livestock stations, as well as on two properties in Papua.

The following is a short description of a programme which was successful at the Lutheran Mission, Boana. Boana is a small mission station about 20 minutes flight from Lae. It is about 3,000 feet about sea level on the southern slopes of the Saruwaged Mountains. Most of the cattle were descendants of pre-war cattle which had been husbanded by the natives during hostilities. The animals involved were seven station cattle and twelve native-owned cattle. During the eradication all the native-owned cattle were concentrated at the Mission.

October, 1950—Cattle found to be tick infested.

December, 1950—All cattle were concentrated at Mission, and spraying with Rucide * at 0.5 per cent. D.D.T. at 14-day intervals commenced.

4th May, 1951—Inspection showed a few mature ticks. Spraying interval was reduced to 12 days and spray strength increased to 1.0 per cent. D.D.T.

15th May, 1951—Inspection was carried out and no ticks were seen.

March, 1952—Spraying reverted to 14-day intervals. No ticks had been seen since inspection 4th May, 1951.

August, 1952—Spraying was discontinued.

October, 1952—Inspection was made and no ticks were found.

November, 1952—Native cattle were moved back to the villages following two sprayings at 10 day intervals. The movement began immediately after second spraying. The pastures at villages had been unstocked for 23 months.

Cattle ticks have not been recovered from any animals in this area since the treatment was completed.

This programme showed that eradication was possible under certain conditions, and demonstrated the following points :—

1. Treatment with Rucide at 0.5 per cent. D.D.T. at fortnightly intervals did not remove infestation in six months.
2. Treatment with Rucide at 1.0 per cent. D.D.T. removed all ticks in one treatment
3. Treatment with Rucide at 1.0 per cent. D.D.T. at intervals of 12 days kept animals free of cattle tick.
4. Eradication is possible using power operated hand spraying to treat animals.
5. Treatment for 16 months after the sighting of the last tick is successful in eradicating tick.
6. Eradication can be carried out by leaving pastures unstocked for 23 months.

All these points were used in planning the methods to be used in the compulsory eradication which was carried out later.

* Rucide (Taubman's) D.D.T. suspension.

A visit by Dr. John Legg, the Director, Animal Research Institute, Yeerongpilly, Queensland, to Papua and New Guinea in October and November, 1950, had a profound effect on the future of the proposed cattle tick eradication plan. His report (Legg, 1951) recommended that—

> "A campaign of tick eradication should be commenced along the lines recommended in this report. It is believed that ticks can gradually be eradicated by making use of newer insecticides."

He observed that cattle in the Territory were in small groups which were effectively isolated from one another by great distances and difficult country. Tick infested herds did not show the massive infestations observed in Queensland, although there were exceptions, and he suggested as reasons the Zebu blood in the animals and the low population density of cattle. The conclusion reached was that eradication had every chance of success, and should be carried out while the population was low, and the Territory then kept tick free by strict control of imported animals.

The recommendations for the eradication of cattle tick were set out as follows:—

1. All stock movement to be controlled and based upon a permit system so that new centres of infestation are not created.
2. Eradication can be commenced in certain defined areas on a compulsory basis, e.g., those offering the best prospects of immediate success, such as Lae (Morobe District), the Central Highlands, etc.
3. All cattle in the area under eradication to be treated on a fortnightly basis with a synthetic insecticide applied by means of a power spray.
4. Missions to be obliged to concentrate cattle in an area under compulsory eradication to facilitate treatment.
5. Only clean cattle go to a freshly opened centre.
6. Owners of stock in districts outside the area under compulsory eradication to be encouraged to eradicate on a voluntary basis, leaving a smaller number of animals to be dealt with under a compulsory scheme.
7. Fortnightly treatments to be continued for 15 months.
8. Where cattle have taken to the bush and are not under control, attempts should be made to yard and paddock them. If this is not feasible they should be destroyed, preferably by shooting.

These recommendations are merely general ones. There are no doubt places where eradication could be immediate, e.g., by cleaning the animals, removing them to clean pasture some miles away, and allowing no entry of cattle to the infested pasture for 15 months.

As can be seen from the description of the Boana eradication, these recommendations with few modifications were successful in eradicating cattle tick.

The compulsory eradication programme could not be carried out without the backing of adequate legislation, so, until the appropriate Ordinance was brought into force, voluntary eradication was the only means available to progress towards the ultimate aim of complete eradication.

The Animal Disease and Control Ordinance (1952) was passed by the Legislative body and was assented to in January, 1953. It was not until January, 1955, however, that Regulations under this Ordinance were gazetted and enabled the compulsory scheme to be put into full effect. This delay of over four years (from Dr. Legg's visit to the stage where compulsory eradication could commence) allowed a more widespread distribution of cattle tick together with a considerable increase in the Territory cattle population making the task of eradication more difficult. During this period control over the movement was impossible, and many of the tick free areas of 1950 and 1951 became tick infested with the constant danger of infection with tick fever. It was fortunate indeed that cases of tick fever were limited to Zenag (Morobe District), Mount Hagen (Western Highlands District), Madang, and Kikori (Gulf District). The total losses from the disease did not exceed 150 head.

There were some exceptions to this general picture of spread of cattle tick where owners strictly followed Departmental

recommendations and carried out successful eradication. These owners reaped the benefit later when compulsory eradication was begun. The recommendations in operation for voluntary eradication at this time were:—

1. The treatment of all cattle and horses with an approved insecticide.
2. The first three sprayings at weekly intervals with B.H.C. 0.05 per cent. gamma isomer or Dieldrin 0.05 per cent.
3. The next five sprayings at 10 day intervals with D.D.T. 1.0 per cent. para para isomer.
4. Remainder of sprayings at fortnightly intervals with D.D.T. 1.0 per cent. para para isomer.
5. Inspect cattle at each spraying and reduce interval between sprayings to 10 days if engorged ticks found.
6. Continue spraying for 15 months from sighting of last tick.
7. Treatment to be carried out with power operated hand sprays.*

A second visit was made to Papua and New Guinea by Dr. John Legg in August and September, 1953, and his report of this visit (Legg, 1953), provides information on the occurrence of tick infestation at that time. He states that the Territory requirement for the importation of cattle from tick infested areas in Australia, which was formulated following his 1950 visit had been successful in preventing the further introduction of cattle tick into the Territory. A considerable number of cattle which had come from heavily tick infested areas of Queensland, were seen by him in clean areas in the Territory, and there was no reason to believe that ticks were brought with them. Some of these animals were closely examined, and although there was evidence that some at least had been at some previous period, heavily infested—as shown by the numerous tick marks—no ticks were seen. No ticks had been sighted on the cattle since their arrival in the Territory.

The requirements stated that cattle from tick infested areas of Australia must be treated with an approved acaricide at least three times at intervals between 5 to 10 days, the last two treatments to be clean treatments (free of cattle tick on individual examination) and the animals moved onto the vessel within 24 hours of the last treatment. The treatments were to be carried out under the supervision of a responsible officer (Veterinary Officer or Stock Inspector). Cattle entering the Territory were given further treatments on arrival. There were at least three treatments and the animals were kept under close surveillance for some considerable time. This requirement still forms the basis of the restriction on the importation of cattle from the tick infested areas of Australia, and also on the restriction on the movement of cattle within the Territory from tick infested areas to clean areas.

Legg's general impression of the situation after inspecting cattle in the main centres in 1953, and comparing them with the findings of 1950, was that in spite of staff shortages and other difficulties the prospects of eradicating ticks from Papua and New Guinea were quite good. It was true that ticks had appeared in some places that were previously clean, but on the other hand there were districts where large numbers of cattle were clean. To keep stock movements under the strictest control was all that was necessary to prevent infestation of new areas. He had observed that although voluntary eradication had been attempted in many instances, successful eradication had not always followed. It was noticeable that this non-success tended to occur where official supervision was not available, and it stressed the need for supervision by a Stock Inspector at all times.

It was as a result of this second visit by Dr. Legg, and the recommendations included in his report, that action was taken to recruit further veterinary and stock inspection staff for the Division of Animal Industry, so that eradication of cattle tick could be commenced on a sound basis of compulsory treatment under supervision. Veterinary staff included laboratory personnel recruited in 1953, and field officers, one recruited in 1955 posted to Morobe District, two in January, 1956, posted to Central District and New Britain District. Two Stock Inspectors were operating in the Morobe District at the time of Dr. Legg's visit, and three other officers commenced

* "Marino" firefighting spray unit.

duties in the Central District, Eastern and Western Highlands Districts and New Britain District in 1954. An officer was stationed in the Madang District late in 1956. Attempts at tick eradication have been carried out in these five districts.

Local control and implementation of the spraying programmes was vested in the stock inspector in the District and the programmes were begun in 1954 under the following conditions. The conditions were laid down by Mr. J. M. Marley, who was Chief of Division of Animal Industry from 1955 to 1958, and was acting in the position at the commencement of the operation.

1. The eradication to be carried out on an area basis, i.e., all cattle and horses in a fixed area, usually one with natural boundaries of distance or difficult country to prevent unauthorized stock movements, to be treated, and all stock movements into these areas strictly controlled.
2. The spraying of all cattle and horses at weekly intervals for a period of 18 months.
3. The treatments to be made with D.D.T. * 1.0 per cent. para para isomer.
4. The cattle to be treated in a crush with a power operated hand directed sprayer.
5. Stock Inspectors to supervise each treatment of properties and submit spraying reports for them.
6. The Administration to supply all acaricide, spraying plants and operators.
7. The cattle owner to be responsible for complete musters of all his cattle and horses, the provision of adequate yards and crush, and the presence of himself or his agent together with labour to work the animals in the yard.

In July, 1956, two further acaricides were included in those approved for use in the eradication programme. These were Dieldrin and Diazinon. D.D.T. was continued at 1.0 per cent. para para isomer, and Dieldrin introduced at 0.075 per cent. active principle and Diazinon at 0.06 per cent. active principle. These three acaricides were alternated on a two monthly basis in the following manner :— D.D.T. Diazinon, Dieldrin, Diazinon, D.D.T., etc., i.e., each acaricide was used for a period of two months and Diazinon alternated after each two month period of D.D.T. and Dieldrin. The percentages of Dieldrin and Diazinon were determined from trials carried out at the Central Veterinary Laboratory, Port Moresby.

This alternate use of different acaricides was facilitated by the method of treatment using power operated hand sprays. The mixture used at each property was made up just prior to use and the concentration of the active principle was accurately known at all times. With the machines in use there was no return of mixture for re-use and the small amounts remaining after treatment of the herd were discarded. This was wasteful of acaricide and it was calculated that about 1½ gallons of mixture was used for each animal with about half of this being lost on the ground. It did have the advantage of accurate knowledge of concentration of the acaricide, the need to mix only sufficient for the animals being treated and the treatment of all animals in small groups on the owner's property with minimum disturbance of normal routine.

To attempt to recover some of the waste acaricide, investigations were carried out into the use of mechanical spray races * where a long draining race enabled the return of part of the mixture carried out on each beast, into the reservoir via a filtering system, and its re-use in the spraying chamber. These spray races facilitate treatment especially where numbers in excess of 200 are to be treated. Cattle and horses move through the spraying chamber in a continuous stream taking out with them slightly less than three-quarters of a gallon of the mixture. The spray races have the following advantages over plunge dips for Territory conditions:—

1. They are cheaper to install.
2. They are less likely to be affected by earth tremors regularly experienced in Papua and New Guinea.
3. They require a charge of mixture sufficient for the animals being treated with a small reserve.

* Formulations included Rucide (Taubmans) and 25 per cent. D.D.T. Emulsion (Shell).

* Cooper "Afgate" and "Waterwall" spray race.

4. They can be used with different acaricides in accordance with the eradication programme.

5. The small quantity of mixture can be made up freshly at each use and so eliminate the risk of using acaricides at reduced concentration.

6. After the first one or two treatments cattle move through the spraying chamber without baulking and are thoroughly wetted by the spraying mixture under high pressure. The race can handle up to 600 cattle per hour and spraying is therefore much faster than dipping.

They have proved most successful in eradication programmes and have been installed on most Government stations, on stock routes, and on several private properties.

The spraying programme was varied in 1958 and reduced the number of sprayings to which animals were subjected. The variation resulted from discussions with officers of the New South Wales Tick Control Board and from a small scale investigation into the life cycle of the cattle tick at the Central Veterinary Laboratory. After the discussion Dieldrin was removed from use in the eradication programme both because of its toxicity and because of experience in other countries of the rapid development of insect resistance to it, and also the concentration of D.D.T. was reduced to 0.5 per cent. para para isomer. The investigation into the life cycle of the cattle tick showed no significant change in the length of the parasitic stage of the cycle from that recorded in Australia. It is this period which is critical in determining the interval between treatments which will not allow ticks to mature. The majority of the ticks detached at 22 days and none detached earlier than the 20th day. This means that treatment at 14-day intervals should adequately cover this parasitic stage of the life cycle. It was felt however that the massive infestations of cattle tick which are experienced in this Territory would be rapidly reduced by the treatment at weekly intervals at the opening of the spraying programme. More frequent spraying would also assist in more rapidly reducing pasture infestation to very low levels by using the sprayed animals as sweepers over the infested pasture. The spraying programme was laid down as follows:—

1. The spraying of all livestock at seven day intervals for the first three months.
2. Thereafter increase the interval between sprayings to 14 days. The spraying to continue until 18 months have elapsed from the last sighting of cattle tick.
3. If cattle tick are sighted at any time during the programme then the three months spraying at seven day intervals recommences before the 14 day sprayings begin again.
4. Initial treatment to be carried out with Diazinon and to be followed by alternate two monthly periods of D.D.T. and Diazinon.

This spraying programme is the one in use at present, with the addition of a new organic phosphate acaricide, Asuntol, into the sequence. Asuntol is used at a concentration of 0.05 per cent. active principle. The concentration of Diazinon was also reduced to 0.05 pr cent. active principle from the level of 0.06 per cent. used previously.

Properties which become infested within the clean areas are placed in quarantine under the *Animal Disease and Control Ordinance* 1952-1958, and the spraying programme is begun. When spraying finishes the property remains in quarantine for a further 12 months. During the total quarantine period, which is a minimum of 30 months from the outbreak, the property is treated as tick infested and any movements off the property are strictly controlled and treated according to the requirements mentioned above. The extension of the tick free areas similarly involves this procedure of quarantine, treatment and inspection.

Eradication Results.

The eradication of cattle tick has been successfully carried out under all the spraying programmes, and the history of the attempts is given by Districts.

Central District, Papua.

The cattle raising areas of this District were not invaded by the Japanese during World War II, and cattle remained in reasonable numbers through the War. The

1 Australian Army Mobile Veterinary Survey Unit (1946) reported cattle tick throughout the District, the heaviest infestations being seen in the Port Moresby area. Army horses became infested and needed occasional treatment. In 1952 cattle tick were collected from a deer, many of which run wild in the forested areas near Port Moresby. Numerous records of cattle tick from cattle and horses in the Port Moresby and Sogeri areas were made until eradication commenced under the supervision of a Stock Inspector in the Sogeri area early in 1954. (The Sogeri area is an upland plateau, averaging about 1,500 feet above sea level, about 30 miles from Port Moresby. It is the valley of the Upper Laloki River). Voluntary eradication had been undertaken by one cattle owner prior to this date and no cattle ticks were sighted on his property although he adjoined two infested properties. His property was also included in the compulsory scheme.

The compulsory scheme commenced in January, 1954, and involved 358 cattle and 78 horses on eight properties. The last spraying was carried out in June, 1955, when 497 cattle and 95 horses were held on the eight properties. This eradication was carried out using 1.0 per cent. para para isomer D.D.T. at weekly intervals for 18 months. The Sogeri area has remained free of cattle tick until an unexplained outbreak occurred on one property in May, 1962. This property is now in quarantine and under an eradication spraying programme. The Sogeri area has been maintained a free area because of the strict control of movements into it, even though the lower Laloki Valley remained a tick infested area. Control was facilitated because of the single road access to the area.

With the completion of the eradication programme in the Sogeri area a start was made on cattle properties in the lower Laloki Valley. This programme was begun in January, 1957, with the treatment of 1,074 cattle and 52 horses on eight properties. The last spraying took place on December, 1958, when there were 1,778 cattle and 78 horses on the properties. In March, 1959 re-infestations were discovered on two properties. Eradication programmes were recommenced early, in the hope that only one or two properties would be involved, but when most properties were reinfested a control programme of spraying at 21-day intervals was introduced. This control programme has been continued to date. This eradication attempt was carried out using weekly treatments of D.D.T., Diazinon, and Dieldrin alternated at two monthly intervals as outlined earlier. The reasons for the breakdown in this attempt have not been accurately determined, but several possibilities showed up in the investigation of it. It is the only attempt in the Territory which has broken down completely. The possible reasons are as follows:—

1. Failure of cattle owners to provide full musters at each spraying date. This became particularly noticeable as cattle numbers on the properties increased. Because spraying was being carried out at weekly intervals, there was no follow up of incomplete musters immediately after treatment, under the supposition that the missing stock would most likely be presented on the next spraying date, and this would still give 14 days between sprayings. In all probability, however, the same animals would be absent from each treatment.
2. The occurrence of wild horses over the fringes of the cattle properties. These animals are known hosts of the cattle tick, and could have maintained it outside the grazing areas.
3. The presence of deer within the grazing areas and outside them. During the eradication spraying programme many deer were shot, but cattle tick was not recorded from them. When the breakdown of the eradication occurred and the cattle carried a heavy infestation of cattle tick for a short period two deer which were shot both carried cattle tick. Studies on captive deer as hosts for cattle tick showed a 0.4 per cent. survival rate of 100,000 larvae applied, when attachment of the larvae was protected by hessian coats. Earlier application of 20,000 larvae without the protection of hessian coats were unsuccessful, there being no engorged adult ticks recovered from the test animals. (Department of Agriculture, Stock and Fisheries, 1961.) In the trials

it was obvious from the severe allergic reaction of the deer and the low survival rate of ticks that the deer are not a favoured host.

4. One property was mechanically infested from one of those in which early breakdown occurred. Pasture planting material was taken from the infested property and planted on the second one. Two months later when the pasture was established and cattle were allowed to graze it an outbreak of cattle tick occurred on the small group of cattle grazing this new pasture. Cattle on other parts of the property were free but the whole property was included in the control programme.

The control programme which was commenced in April, 1959, was designed to reduce the pasture infestation of cattle tick in an attempt to eliminate deer as an effective host of the cattle tick. This is based on an unconfirmed assumption that only while pasture infestation is high do deer carry cattle tick. During the control programme the opportunity has been taken to capture or kill the wild horses, and to shoot out the deer in the grazing areas, and drive them further into the forest areas. There have been no recordings of cattle tick from deer shot since the control programme commenced. It is planned to re-introduce an eradication spraying programme about January, 1964.

Extension of eradication programmes to other areas of the Central District has not been undertaken. It is planned to initiate spraying in the Kairuku and Goilala Subdistricts north-west of Port Moresby as the next stage of the Central District programme. There are several properties along the south coast of the District which have not been included in any eradication attempt, because they are sufficiently isolated by distance and difficult country from the main cattle raising areas, and there is no movement of cattle from them to other parts of the Territory. These isolated properties will be some of the last to be tackled in the eradication programme.

Milne Bay District, Papua.

Cattle populations in this District are in the same category as the isolated properties along the south coast of the Central District. No eradication attempts have been made and the extension of eradication to the District will await success in other Districts where the cattle population is larger. There are 570 cattle in the District of which only a small number on isolated islands is tick free.

Northern District, Papua.

All cattle introduced to this District were tick free on arrival and the District has remained a clean area. There are 997 cattle in the District.

Gulf District, Papua.

There is only a small number of cattle in the District. One voluntary eradication programme on 10 head was undertaken and was successful. The remainder of the District's cattle is infested. Further voluntary schemes may be of importance and are under investigation.

Western District, Papua.

Only three small herds are present in the District. One of these is tick infested while the others are tick free having been new areas stocked with clean cattle. The protection of free areas in this District may be complicated by the presence of deer, and their migration to and from the Merauke area of West New Guinea, which is tick infested. There are 99 cattle in the District of which 12 are tick free.

Morobe District, New Guinea.

The only cattle remaining in this District after the war were the remnants of the drove of cattle from Madang, and a few mission owned cattle which were herded by the native people and hidden from the troops. All these cattle were tick infested. The Morobe District contains the areas of the Territory which have the greatest potential for cattle development. Several large properties have been taken up for grazing purposes by expatriate settlers and the number of cattle owned by native villagers is the largest by far of any district in the Territory. The district carries almost 40 per cent. of the Territory cattle population at the moment.

The potential of the District was recognised early, and the voluntary eradication schemes were first introduced there. The Boana programme mentioned earlier was successful in eliminating cattle tick from the area in which the establishment of cattle in the village economy has taken place. A second voluntary scheme removed the cattle tick from the small number of cattle on the coast adjacent to Lae. Two schemes were successful in the Wau Valley and one was unsuccessful. A second scheme was also unsuccessful in an upland area closer to Lae. The cattle in these unsuccessful attempts were later cleansed in compulsory schemes controlled by the Department.

At the time of the completion of the compulsory schemes in early 1957 all cattle in the District were tick free. New properties were being developed and stocked with clean cattle. The majority of these cattle were imported from Queensland, and had been subjected to acaricide treatments according to the requirements, i.e., three treatments at five to ten-day intervals, the last two treatments to be clean treatments as determined by individual inspection. They were again treated on arrival in the Territory in most cases for a further three treatments at five to ten-day intervals. Following one introduction of cattle from North Queensland in 1957 an outbreak of cattle tick was discovered on the quarantine station, but it had already spread to two other properties in the district. The properties, involving 1,171 cattle, were placed under eradication spraying programmes in February, 1958. The spraying programme on one of these properties was satisfactorily completed in 18 months and the quarantine was lifted in a further twelve months (August 1960). On the other two properties reinfestations were seen in January, 1959, and the spraying programme was extended for a further 18 months. Spraying was completed in May, 1960, and the quarantine was lifted in September, 1961. Since this date there have been no further outbreaks. At the same time as these outbreaks were under eradication a voluntary eradication was undertaken in the Finschhafen area. This attempt was successful even though it was not carried out strictly according to the programme. Its successful completion eliminated the last pocket of cattle tick in the District, which now has a population of 8,675 cattle which are tick free.

Eastern Highlands District and Western Highlands District.

These two districts will be dealt with as one since the eradication in both was carried out simultaneously, and was under the supervision of the Stock Inspector stationed at Banz in the Western Highlands.

The first treatments of cattle in the Districts began early in 1953. By March, 1954, 17 properties were under treatment involving 593 cattle and 204 horses and donkeys. The last spraying treatment was carried out in September 1955, with the exception of two isolated mission properties that began their spraying later than March, 1954. Inspections then showed that the programme was successful. The districts remained tick free until an outbreak occurred near Goroka in December 1958, on two properties involving 20 cattle and four horses. Three cattle had been introduced from the Madang District under the supervision of a Stock Inspector, and had received the prescribed three sprayings at five to ten-day intervals. They had been inspected at each spraying and no ticks were seen. The animals were moved by air in September, 1958 and the outbreak discovered in December, 1958. Quarantine was imposed on the properties in January, 1959 and sprayings ceased in June, 1960. The quarantine was lifted in August, 1961. There has been no reinfestation of the Districts, which now carry 3,982 tick-free cattle.

Southern Highlands District.

This District was stocked with tick-free cattle from herds in the Western Highlands District and ticks have never been recorded in the District. There are 59 cattle in the District.

Madang District.

Some cattle remained in this District from stock held on the plantations prior to the War. Numbers of these were recovered from the bush to help re-stock plantations. These were tick infested and also carried the organisms of

tick fever. Further cattle were imported (many from tick free areas of Australia), and because no attempt was made to control the cattle tick, losses were experienced in the imported cattle from tick fever. Cattle tick eradication began in the District in 1958, after some preliminary work in organizing suitable handling facilities on properties, and determining the numbers of cattle to be included in the eradication attempt. Six properties were included in 1958, and these carried 374 cattle. By the end of 1959 eight further properties carrying 531 cattle and 60 horses had been added to the eradication programme. The only additions to the programme later than this was one property carrying 16 water buffalo and a group of native owned cattle, 12 head, which were in an area inaccessible by road from Madang. This last herd was left in strict isolation until the Stock Inspector completed spraying on some of the other properties in the eradication area, and could spare the time for the two day journey to treat this small herd.

Eleven of the 16 properties completed their spraying programmes in the minimum period of 18 months. Two properties took 20 months, one took 21 months and two properties were under spraying for 30 months. These delays were due to the observation of cattle tick on animals in the herds. The two properties under treatment for 30 months were involved in the outbreak on the water buffalo. The buffalo proved almost impossible to muster and treat. Some of the most intractable animals were slaughtered before the group was finally brought under control.

Cattle tick have not been sighted within the eradication area of the Madang District since October 1960, but the twelve month period of inspection on some properties has not yet elapsed so the quarantine on the area has not been lifted. The eradication area extends from Madang northwards, a distance of approximately 60 miles. Action has been taken to extend the area southwards towards the Morobe District border, there being only one small pocket of tick infested cattle in this direction.

Difficult country separates the northern boundary of the eradication area from further tick infested cattle to the north. These are found around Bogia near the mouth of the Ramu River. About 550 head of cattle are involved but the position is complicated by the presence of an unknown number of wild cattle and water buffalo in close proximity to plantation cattle. It is intended to leave the Bogia area until other areas are completed and action can be taken to control or slaughter out the wild cattle and water buffalo.

Other areas of the Madang District particularly in the upper reaches of the Ramu River, have been stocked with tick-free cattle via the port of Lae. The natural outlet for this area is via the Markham Valley to Lae.

Sepik District.

No formal eradication programme has been undertaken in this District. Cattle tick remained on wild cattle which were recaptured after the War. A voluntary eradication programme at Aitape was successful prior to stocking with cattle imported from Australia, and the herd has remained tick free since then. A second eradication near Wewak was carried out by treatment and movement to fresh pastures, the original area being left unstocked for the cattle tick to die of starvation. This attempt was successful, but almost three years later reinfestation occurred when carcases of beef from the Bogia area were introduced to Wewak. The beef was poorly slaughtered and pieces of skin remained on the carcase. It was transported direct to Wewak wrapped partly in the hide and in leaves. This outbreak was in two herds and has been treated in two ways. One was sprayed weekly for six weeks and moved to new pasture. It has remained tick free for over 12 months. The second herd was sprayed under a voluntary scheme but reinfestation occurred followed by an outbreak of tick fever. The spraying has since been carried out under Departmental supervision and over half the herd has been transferred to new pastures.

The situation in the Sepik District is uncertain at the moment, but it is the District into which the eradication programme moves next. Of a District cattle population of about 550 head, 250 in two herds are known to be tick infested.

Manus District.

The cattle population in this District is small. All herds are on isolated islands and in the main are tick free. The actual status of some of the cattle is uncertain.

New Ireland District.

Eradication has not been undertaken in this District although large areas of the main island have been stocked with clean cattle. Tick infested cattle are present on plantations in Southern New Ireland, but distance and difficult country separate these plantations from the tick free area. Islands to the north of Kavieng also have herds of cattle, and one island in particular has a large herd of water buffalo. The cattle tick status of these herds has not been investigated because their insular isolation prevents any possible reinfestations of controlled cattle herds. Islands to the east of New Ireland also have tick infested herds on them. It is intended to begin voluntary eradication schemes on these herds in the near future.

New Britain District.

The first attempts to eradicate cattle tick in this District followed the posting of a Stock Inspector to the District late in 1953. Only two properties were infested. These carried a total of 553 cattle and 12 horses. Because the cattle were owned by a company which had several other properties in the area, the number of cattle under treatment was progressively reduced by movement to clean properties. Three horses and 369 cattle still remained under treatment when the spraying programme ended in December, 1955. Reinfestation occurred on one of these properties in July, 1956. Weekly spraying treatments were carried out until December, 1956, when all cattle were removed to another property. An outbreak occurred on this second property and there was no doubt that this infestation arose from the transfer of ticks from the original property. The source of the infestation on the original property was thought to be from the presence of deer and a small focus of infested wild cattle near to the property. There were 408 cattle involved in the spraying programme which was carried out until July, 1958. No reinfestation of the property has been recorded to date.

A second reinfestation occurred on a different property in the same area in May, 1960. This property has not been infested since the completion of eradication spraying in March, 1955. This outbreak involved 131 cattle. Spraying was completed in December, 1961 and no reinfestation has been observed. A third reinfestation occurred in March, 1961 on a property close to that involved in the second reinfestation. This outbreak involved only seven head of catle.

This succession of reinfestations on properties in this area of the New Britain District would indicate the presence of a source of infestation outside the present grazing areas. There is rumoured to be still present near to the area a number of wild cattle and deer which roam through the plantations and jungle of the area. The increase in population has tended to drive the deer from the grazing areas, but occasional ones are still seen. The area is becoming of less importance in the Territory cattle industry because of the increase in plantings of cacao in coconut plantations. Cacao plantings are taking over previous grazing areas.

In order to protect the cleansed areas of the District the programme must be extended to eliminate the pockets of infestation of wild cattle and deer close to them

Bougainville District.

There was only a small number of animals remaining in this District after the war. No formal eradication programme has been undertaken although a number of small herds in the District are tick free. The main infestation is in herds in the Kieta Subdistrict. The isolation of the District has not warranted its inclusion in the formal eradication programme to date.

To summarise the present status of cattle in the various Districts the following table has been compiled based on population figures at 30th June, 1962.

Table I.

Cattle Population—Territory Papua and New Guinea Cattle Tick Status 30th June, 1962.

District	Total Cattle	Tick-Free Cattle	Cattle Under Treatment	Tick Infested or Unknown
Papua				
Central	4,602	1,590	2,345	667
Gulf	120	10	....	110
Milne Bay	570	....	....	570
Northern	997	997	....	....
Southern Highlands	59	59	....	....
Western	99	12	....	87
New Guinea				
Bougainville	124	....	....	124
Eastern Highlands	1,863	1,863	....	....
Madang	2,340	1,699	20	621
Manus	165	....	....	165
Morobe	8,675	8,675	....	....
New Britain	1,403	1,067	11	325
New Ireland	643	225	....	418
Sepik	559	300	....	259
Western Highlands	2,117	2,117	....	....
TOTALS	24,336	18,614	2,376	3,346

SUMMARY.

A short history of the progress in the eradication of cattle tick (*Boophilus microplus*) from the Territory of Papua and New Guinea is given together with the materials and the methods used in the eradication attempts. In general the eradication attempts have been successful with only one area showing a complete breakdown in the attempt. Cattle ticks have been eliminated from a large area of the Territory, particularly from the Districts where the greatest potential exists for the future development of a large cattle industry. Of a total Territory cattle population of 24,336 head, 18,614 head are tick free, 2,376 are under eradication or control treatment and the remainder are either tick infested or their status unknown. If future progress in eradication attempts can be measured from past successes then the goal of complete eradication is within reach, and it will rest with efficient quarantine services to maintain the tick free status.

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