

A Plague Survey of Ngamiland, Bechuanaland Protectorate, During the Epidemic of 1944-45

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INTRODUCTION.

PLAGUE in wild rodents was active on the southern border of the Kalahari in 1928. It spread rapidly from the North-West Cape through South-West Africa and Bechuanaland and reached Ovamboland in 1931 (Fourie, 1932) to give rise to the first human outbreaks in the Kalahari. Spread continued into Angola from Ovamboland. At the same time Ngamiland rodents suffered invasion, but no human infections were contracted until October, 1944. Plague was thus enzootic for nearly fifteen years in Ngamiland. During this period a major epizootic took place in 1934-5 (Fourie, 1935), and on the supposition that the 4-5-year epizootic cycle was at work as in other parts of South Africa, a further epizootic probably took place about 1939-40.

The Bechuanaland Government had disbanded its Rodent Staff when the 1935 scare died down (Gerber, 1935). The epidemic was unforeseen and came as a complete surprise. The emergency was vigorously met by the Medical Department under the initial direction of Sir Walter Johnson, then Director of Medical Services for the High Commission Territories, who not only had had experience of combating plague in Nigeria, but who was also visiting the territory on a medical tour of Ngamiland, with Dr. D. J. M. Mackenzie, Deputy Director of Medical Services, Bechuanaland Protectorate. The Government of Southern Rhodesia, in answer to an appeal for assistance in controlling the epidemic, sent Dr. E. Baker Jones (Health Officer) and Mr. H. V. Venables (Senior Health Inspector). In the fortnight at their disposal they carried out surveys of the Maun and Lake Ngami areas with the Medical Department and, amongst other contributions, and after intensive search for active rodent plague, demonstrated *P. pestis* in rodents dying near Maun. While they were in the field Sir Walter returned to Pretoria and discussed the situation with the Secretary for Public Health, who had offered assistance in response to a request from the Bechuanaland Government. Sir Walter was satisfied that the epidemic was under control, but he was anxious that the measures in operation should be checked and that a thorough survey should be done to elucidate the factors that brought the epidemic about. I was instructed to make preparations for the expedition and to proceed to Francistown, accompanied by a Plague Inspector, on 23rd November. From Francistown we would proceed by lorry to Maun and thence to the affected areas.

OBJECTS AND METHODS OF THE SURVEY.

The scientific object of the survey was to investigate the ecology of the rodent and flea fauna of Ngamiland and to trace the course and history of the epizootic in the rodent populations which had culminated in the epidemic. The practical object was to check the anti-plague measures in operation and to make suggestions for improvements where indicated.

The itinerary followed is shown on the accompanying sketch-map. It will be noted that from Maun the three main outbreak centres lay about 60 miles to the south-west (Sehitwa), 40 miles to the south-east (Makalamabedi), and 100 miles to the south-east (Rakops), respectively. The two former areas could be reached in half a day and the latter in a day. The epidemic had first been discovered at Sehitwa in the Lake Ngami region, then at Makalamabedi, and finally at Rakops. At the time of the survey the epidemic had almost spent itself, but sporadic outbreaks were continuing at Rakops.

In all about 2,000 miles were covered in six weeks. Daily journeys of up to 100 miles were made involving seven to ten hours' travelling. It was rarely possible to spend more than

one night at a camp. Surveys of the state of the rodents on all routes covered were made at frequent intervals. Approximately ten minutes per hour were given to roadside surveys (i.e. every 10-15 miles). When travelling at night the number of rodents seen in the headlights was noted down and many thus seen were caught by hand. At each camping-place two or three dozen traps were set in a loop-line from the camp. They were inspected two or three times before midnight and again at 6 a.m. The collection of fleas from the catch and the making up of skins for identification took up an hour or two each morning. Camp was usually made at about 6 p.m. and broken at 10 a.m. the following morning.

In all 153 small rodents of eleven different species were collected and examined for fleas. From these 1,005 fleas of five different species were collected. (See map on next page.)

NARRATIVE OF THE SURVEY.

FRANCISTOWN-MAUN.

The expedition left Francistown by 3-ton lorry on the afternoon of November 25. Field observations were begun immediately. As the country and its rodent fauna were unfamiliar a considerable amount of time was spent *en route* to Maun in making surveys and in preserving specimens, with the result that the journey took a day longer than had been planned.

The gerbil (*Tatera*) population along the whole route from Francistown to Maun showed signs of having been heavily decimated by epizootic disease during the previous nine to twelve months. At most points the gerbil epizootic was long past, but at a few points sporadic mortality amongst the few survivors still appeared to be taking place. Surface indications of the occupation of burrows were slight, and at some of the trapping points the burrows gave every appearance of being deserted. In spite of this one or two gerbils were usually trapped, but often late at night or between midnight and early morning; gerbils were evidently present in very small numbers and roaming widely in search of food, leaving little surface indication of their presence. This picture of the state of the gerbil population was found to fit almost all the other areas subsequently surveyed, even to the Zambesi and Victoria Falls.

There were few settlements along the route to Maun. At Mosetse, a W.N.L.A. Rest Camp, multimammate mice (*Mastomys coucha*) and golden rats (*Ethomys namaquensis*) were found in the thatched roofs and walls of the huts. Multimammate mice are the most numerous and important domestic rodents and are responsible for bringing plague infection from gerbils in the veld into contact with man and huts. It was unexpected to find them in the thatch and more unexpected to find this niche occupied by golden rats as well. It was later found that tree-rats (*Thallomys*) exploit the same habitat, and that it was the rule rather than the exception for multimammate mice to live in the thatch as well as in the walls and under the floors of huts. As these three species harbour the flea *Xenopsylla brasiliensis* (the chief vector of plague to man) both when they are living in the veld and in huts, the epidemiological significance of their "thatch-exploitation" habits is considerable. Ngamiland huts are lightly constructed and small. The walls are usually made of poles or reeds plastered with mud, and there is little doubt that hut structure is the decisive factor in giving multimammate mice access to the thatched roofs. The house rat (*Rattus rattus*) has not yet invaded the Kalahari and is not likely to owing to the arid nature of the country.

On reaching Maun on 29th November we reported to Dr. M. L. Freedman and learnt that cases of plague were still cropping up at Rakops, but that the Lake Ngami area and Makalamabedi were quiet. Dr. Freedman was anxious that we should proceed to Rakops as quickly as possible as he had arranged for the District Commissioner (Serowe), Mr. Forbes Mackenzie, and Dr. Royer, Medical Officer, Seventh Day Adventist Mission (Maun), to meet us there. We accordingly left Maun the following day in the late afternoon. The direct road to Rakops was out of commission as the drift across the Botletle River at Samedupe was still under deep water. So, proceeding on the main route to Lake Ngami as far as Kgantsan (15 miles from Maun), we cut across on a temporary road to join the main route at Samedupe at nightfall. Through

this section, done in daylight, enough observations were made *en route* to show that very few gerbils still survived. Burrows were in evidence along almost the whole route and in some places were extremely dense, but little sign of occupation was detected.

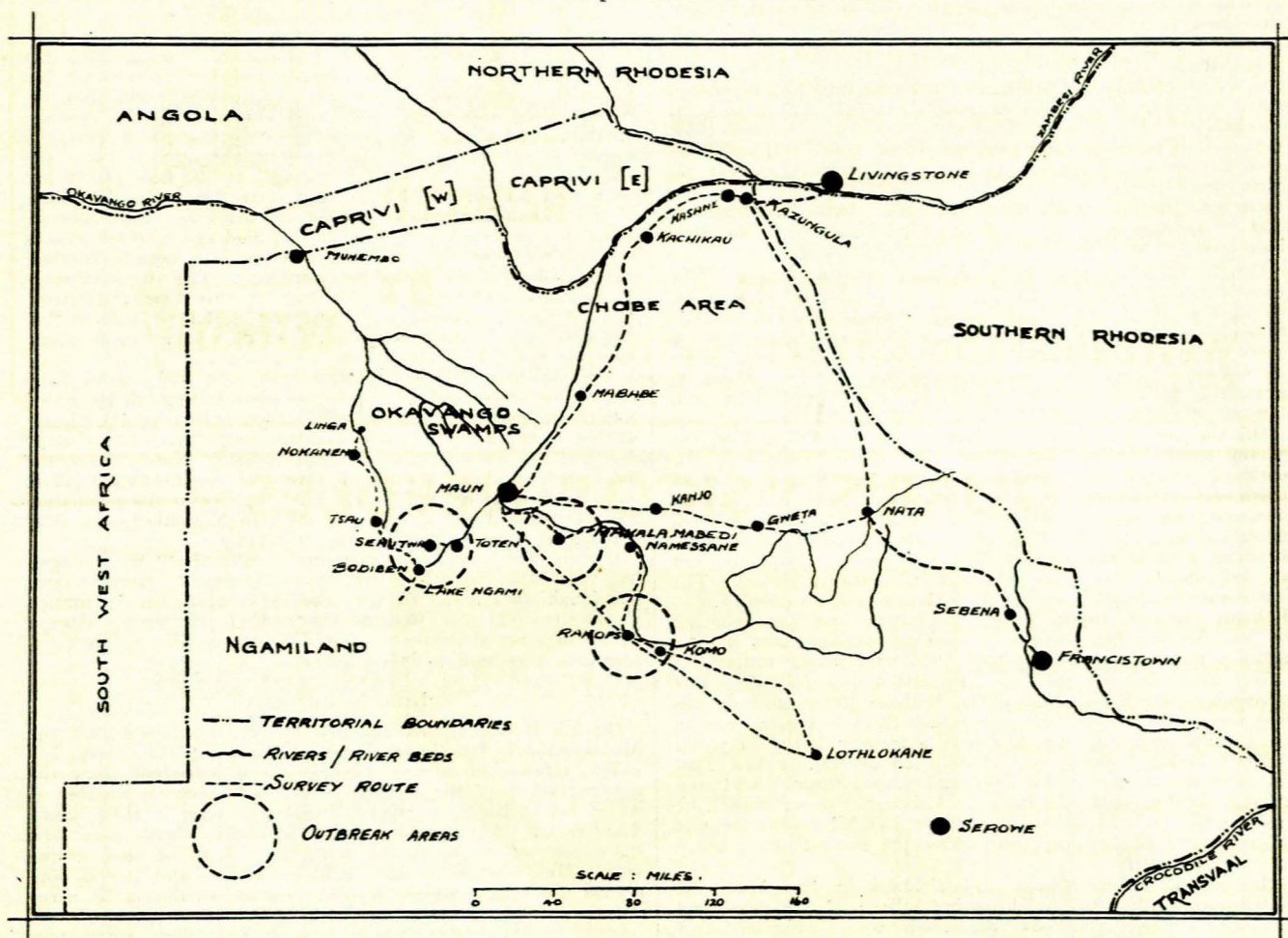
RAKOPS AREA.

The road to Rakops from Samedupe cuts across typical Kalahari sandveld. The Botletle River—along which from Makalamabedi to Rakops sporadic outbreaks of plague had occurred—lay away to the left (north) of the road. This section was later crossed in daylight by Inspector Geldenhuys, who found it riddled with deserted gerbil burrows. Travelling over it at night, only a few paeba gerbils (*Gerbillus*) were seen at one point. After covering about 100 miles camp was

quarantine area impressing on the people the necessity of abiding by the stand-still order, and ordering them to clean up their villages by burning the accumulations of rubbish in the thorn kraal hedges and around the huts. The population was becoming restive under the quarantine restrictions, and it was suspected that inter-kraal visiting was aggravating the plague position. To the African mind the plague epidemic was the result of the filling of the Botletle River for the first time in many years. The people alleged that the spraying and gassing of huts and the inoculations were causing the sickness, and that treatment with serum and sulphathiazole pills was poisoning them.

Owing to shortage of staff it was impossible for the Medical Department to keep a medical officer in any one area long

FIG. 1.—Sketch-map of Northern Bechuanaland.



made in a belt of camel-thorn trees some twenty miles from Rakops. At this point the country opens out into the ancient flood plain of the Botletle River. It is composed of "vlei" soil and is for the most part unsuitable for gerbils, though a number of springhare warrens was seen, most of which were unoccupied.

The villages in the Rakops area are for the most part situated above the general level of the plain (which gets flooded in heavy rains) on rises of sandier ground. The vast gerbil territory in the sandveld a few miles to the south of the river was the source from which the epizootic spread to the scattered isolated colonies in the sandier parts near the river where the kraals and villages were situated.

We reached Rakops at about midday on December 1. Mr. Mackenzie had already been systematically through the

enough to convince the people of the true nature of the disease or to determine the detailed histories of cases and outbreaks. Mr. F. H. White, Stock Inspector for the Rakops area, had volunteered to assist the Medical Department, and was doing excellent work in diagnosing cases of plague and in giving treatment. On our arrival, he had just completed a tour with Dr. Royer of the villages in which plague patients were lying, and was on the point of investigating a report of a sudden death at a cattle post nearby. The symptoms described—short illness, cough and blood-stained sputum—were strongly suggestive of pneumonic plague. On visiting the post it was found that the body had been buried but none of the contacts was sick. On questioning the inmates, it transpired that a series of similar sudden deaths had occurred at or near this post at roughly weekly intervals since the beginning of November. It

was unfortunately not possible to exhume the body to carry out a post-mortem, as this would have needed the Chief's sanction, which was unobtainable. Further, the people were strongly opposed to any interference with a body before or after burial. The close contacts were given serum and arrangements made for the members of the kraal to be examined daily. No developments subsequently took place and the outbreak was regarded as suspected pneumonic plague.

Up to 23rd November a total of 50 cases and 37 deaths had been reported in the Rakops area on a stretch of about twenty-five miles along the south bank of the Botletle River. The majority of the cases were of bubonic plague, but there had been a number of rapidly fatal septicæmic cases, none of which was seen, as they were dead and buried before the report came in. In view of the suspicions that pneumonic plague was responsible for the deaths at the cattle post and the evidence of Mr. White as to the symptoms described by persons reporting some of the sudden deaths, it seemed likely that some of these rapidly fatal cases had been of pneumonic plague.

Dr. Royer returned to Maun to report on the Rakops area the following day. The suspected pneumonic plague needed further investigation, and reorganisation and amplification of the anti-rodent staff in the area was necessary. It was decided that, after inspecting the immediate vicinity of Rakops, we should accompany the District Commissioner as far as Lothlokane on his return to Serowe, and then proceed up the river road to Makalamabedi to get in touch with Dr. Freedman, and to arrange the details of the reorganisation of the anti-rodent work in the Rakops area.

On December 4th we left Rakops for Lothlokane. The epizootic picture was similar to that already seen. No suspicious illness was discovered at Lothlokane. The District Commissioner on his return to Serowe undertook to make a survey of that stretch. He later reported that he could detect no difference in the state of the burrows between those he examined with us on his way to Lothlokane and those seen towards Serowe.

On the return journey to Rakops via Chukutsa Pan the survey results differed in no way from those obtained on the outward journey on a different route. At Komo, 15 miles south-east of Rakops, where several outbreaks had already occurred, we were told of sick people in one kraal. On investigation a young woman was found ill with an inguinal swelling, a child had already died with similar symptoms, and an old woman was sick, but with no swollen glands. The kraal was thoroughly gassed the next day and we proceeded to Rakops. In our absence several more cases had been reported to Mr. White, but there had been no developments at the cattle post amongst the suspected pneumonic plague contacts.

We were due to meet Dr. Freedman the following day (December 7th) 100 miles up the Botletle River, and on the way to enquire at each village whether there had been or were cases of plague. As the road was extremely heavy in parts, we left Rakops almost immediately on arrival. The road followed the course of the river and passed through scattered villages located along its banks. Although the soil was light and sandy, very little evidence of past gerbil occupation was evident until Namessane, near where the river takes a sharp turn to the west.

Reports of recent deaths and sickness in two kraals at Namessane and in the neighbouring village of Gwaraga were received. The symptoms described were suggestive of pneumonic plague. One old woman was still alive, but very ill. She had a weak cough and complained of pains in the chest, and it was alleged that her sputum contained blood. The headman was instructed to place one attendant in charge of the sick woman and to allow no one to sleep in the hut and to isolate similarly other like cases. As we were faced with the heaviest stretch of road ahead, and were due at Makalamabedi that night, no further investigations were made and we pushed on to report our suspicions as quickly as possible.

About twenty miles further on we received a report of a single fatal case of bubonic plague at the village of Moremaut, on the river off the main route. Shortly after passing the neighbourhood of this village we stopped at dusk at the village of Magaudi, lying close to the river. Some fairly active gerbil warrens were discovered in an open grassy patch running down to the river's edge. Traps were set and in two hours

a number of gerbils and other rodents were caught. This was the first instance of anything approaching normal gerbil occupation to be seen.

Similar isolated warrens such as this were seen sparingly in the Lake Ngami area later in the survey. They are to be regarded as the first indication of recovery of the gerbil population.

MAKALAMABEDI AREA.

We reached Makalamabedi at midnight. The following day, after discussing the results of the survey with Dr. Freedman, a visit was paid to a village which had suffered a number of outbreaks. Dr. Freedman had with him Mr. Theunissen, Health Inspector; Rodent Inspector Erasmus, who had been recalled from the Lake Ngami area; and Mr. Drotsky, Assistant Rodent Inspector, who had been in charge of gassing, etc., in the Makalamabedi area. The Rodent Inspectors were to leave that day for Rakops to speed up work there, but before they went Inspector Geldenhuys demonstrated how to make the best use of the cyanogas pump in gassing huts, with special attention to the methods of dealing with the thatched roofs. Too much reliance had been placed on hut fumigation (i.e. pumping the interior full of cyanogas from the outside), and it was not sufficiently realised that the essential operation was to get the gas into close contact with fleas and rodents surviving in the burrows in the floors, walls and thatch and to leave a layer of cyanogas on the floor of the hut as a final measure to destroy any stray fleas. In the course of the demonstration a number of dried-up multimammate carcasses were found lying as they had died two to three months previously, before any control measure had been instituted, amongst some hides in an abandoned hut. The virtual absence of multimammate mice in the huts at this time (December) and during the epidemic, both here and at Rakops, showed that the main source of infection was from fleas surviving in nests, burrows, grain bins, etc., in the village huts.

The epidemic in the Makalamabedi area had subsided by the middle of November. Up to the week ending 5th December there had been 62 cases and 34 deaths, chiefly in the closely settled communities around Makalamabedi itself, but also at scattered points up and down the Botletle River. Here the mass immunisation appears to have had a considerable effect on the course of the epidemic. The majority of the population had been inoculated by the first week in November, and after the second week new cases fell off rapidly.

Gerbils had been very numerous round about the villages, but very little current occupation was observed. Reports from the inhabitants indicated that there was a sudden diminution in numbers of mice towards the end of the winter after a period of great abundance. In addition to multimammate mice, tree rats were said to infest huts.

LAKE NGAMI AREA.

On 9th December, accompanied by Mr. Theunissen, we left Makalamabedi for Lake Ngami, examining *en route* hut rodent infestation between Chanogha and Samedupe along the upper reaches of the Botletle River to determine whether it would be advisable to allow ploughing to start in these areas. The gerbil epizootic was over, although there were few indications of recent rodent mortality still to be seen on the veld. Hut infestation was slight or absent, and it was concluded that an increase in the resident population to carry out the ploughing would not be attended by undue risk. We joined the Maun-Lake Ngami road at Kgantshan, which now followed the course of the Ngabe River through the Xnaragha Valley outside the tsetse belt. Gerbil burrows, from being extremely densely distributed in the camel-thorn woodland, became more scattered and patchy towards Moana, ten miles from the east end of Lake Ngami. There was slightly more evidence of gerbil occupation here, and evidence of secondary infection of golden rats was secured by finding the remains of one in a crevice at the foot of the baobab tree giving its name to the locality (Moana). The journey from Moana to Toten and Sehitwa to Tsau was done at night. On the 50-mile stretch between Sehitwa and Tsau only 12 small rodents and 40 springhares were seen in or near the road. Corporal Whitson, N.C.O., Tsau, upon whom we called next day, had noted a steady diminution in the numbers of small rodents and springhares seen at night on this same stretch of road. In July he estimated that he saw a rodent every

20 to 30 yards and large numbers of springhares. In October rodents were much scarcer and he saw about 200 springhares.

Corporal Whitson was the first to send in an official report on rodent mortality in May, 1944. Noting the unusual abundance of rodents, he had been on the look-out for mortality. His first report came from the Makakun area, about twelve miles south of Tsau, at the end of May. Later, mortality was reported or observed in most parts of his district (Lake Ngami area). His report was passed to the Veterinary Department, who replied some time later that the mortality might be due to plague or rabies and sent a request for specimens. At this time (end of June) specimens were hard to get, and those that were sent were damaged in transit and never reached Johannesburg. The Medical Department was not informed of the mortality. Only rumours of intense activity, presumed to be due to concentration of rodents on account of the floods, reached the Department. It was not until October, when the human deaths started at Sehitiwa, that the importance of these early reports was realised. At the same time as Mr. Openshaw, storekeeper at Sehitiwa, reported five sudden deaths at the beginning of October, Corporal Whitson was investigating a suspected murder case. A witness took ill and died during the proceedings at Toton of what was in retrospect undoubtedly bubonic plague. The victim in the suspected murder case was almost certainly a victim of plague.

Anti-rodent work in the Tsau-Nokanen area was being done by the storekeeper at Tsau, Mr. Kyriacou, who had volunteered to assist the Medical Department when his store was closed to discourage movement in the Tsau area following one case of plague. Shortly before our visit mortality had been reported in the vicinity of Bojankwe between Tsau and Nokanen. The report had been followed up, but no conclusive evidence of rodent mortality had been discovered, mice still being quite abundant in some of the villages.

On 11th December we took the river road from Tsau towards Nokanen, camping near the village of Kwee, near Bojankwe, from which the reports of rodent mortality had been received. Between Tsau and Bojankwe gerbil burrows were all virtually deserted. The huts at Bojankwe were almost free of rodents, although they had been heavily infested during the winter. The village of Kwee, five miles further on, presented a striking contrast. Almost every hut examined was alive with multimammate mice; they were especially numerous in the granary huts, in one of which a dozen were caught in the bins or while running round the thatch. A dried-up multimammate mouse carcass was found in a grain bin in another part of the village, indicating that there was some foundation for the mortality reports. The evidence, however, was not of recent mortality, and the conclusion was come to that these villages might still escape infection. It was a mystery how the mice escaped infection in the presence of such a widespread epizootic in gerbils and other veld rodents and in rodents in the neighbouring villages.

On reaching Nokanen, we got into touch with Mr. Kyriacou and learnt from him that he was organising a gassing campaign in the Bojankwe area. From Tsau to Nokanen the gerbil population had been almost obliterated during the winter epizootic, and no indication was seen of re-grouping of survivors. Mr. Kyriacou, however, had noticed that at Linga, a few miles north-east of Nokanen, some colonies were active. On visiting the area, this proved to be the case: many of the burrows were old, closed up, and with grass growing over them, but a small number were being reopened and were in regular occupation. The grain in a group of huts nearby had been severely attacked by multimammate mice, the germ of almost every mealie having been eaten out. The occupants informed us that mice had been very abundant in the winter and that they had died out between July and September.

On 12th December we returned to Lake Ngami. Up to the week ending 5th December 135 cases and 45 deaths had been reported from many of the villages scattered about the perimeter of the Lake bed. The epidemic subsided early in November, a week or two after the population had been immunised. On the face of it it would seem that the immunisation campaign had influenced the course of the epidemic as it had done at Makalamabedi.

Whereas the field evidence pointed to the gerbil epizootic being still in progress at isolated points in the Rakops area, and to have subsided almost completely in the Makalamabedi

area, it was evident that there was some recovery taking place in the Lake area. Well-marked tracks from one burrow to another indicated settled occupation which would result in increase at the onset of the next breeding period. The possibility of a secondary epizootic in gerbils consequent upon "back-pressure" infection from multimammate mice and other rodents would not, however, be ruled out.

On the return journey to Maun on 14th December, gerbils were found re-colonising a few old warrens between Toton and Moana between the Naraga and Ngabe Rivers. From Moana to Maun the very few surviving gerbils were still roaming widely, leaving little evidence of their presence.

MAUN AREA.

Before leaving for Kazungula on the last lap of the survey Inspector Geldenhuys volunteered to go to Rakops to check over the anti-rodent work there and to bring back reports, as no news had come through since the reorganisation of the gangs and intensification of operations in that area had been undertaken since our visit. On his return he was able to report that the work was proceeding satisfactorily. While he was away I accompanied Dr. Freedman to Shorobe, 25 miles north of Maun, to examine the villages in particular. The degree of rodent infestation of the huts was slight and there was little sign of much heavier past infestation. The epizootic had been as sweeping in its effects as elsewhere, and there appeared to be slightly less activity amongst the gerbils than a month previously, when Dr. Baker-Jones examined the same areas.

We also visited the Bushman Pits area, where a certain amount of gerbil activity had been noted on 29th November. Then there was some uncertainty as to whether the gerbils were healthy or not. Little change, however, was detected, and it seemed fairly certain that re-colonisation, prior to increase, was taking place.

MAUN-KAZUNGULA.

As rain was threatening in the north, it was decided to get through to Kazungula as soon as possible. Heavy rain makes sections of the road in the Mababe Flats area impassable, sometimes for weeks at a time, and we did not wish to miss discussing the implications of the Ngamiland panzootic with the authorities from Northern and Southern Rhodesia, whom we hoped to meet at Kazungula or Livingstone. We therefore left on the afternoon of December 13 and travelled through the night. Heavy rain was experienced in the Mababe Flats area, but fortunately no rain had fallen in the black soil belt at Tsotsorogha.

Although little could be done on this section, it was evident that the country from Maun northwards up the eastern edge of the Okavango Swamps to the Chobe River has been the scene of as severe an epizootic in gerbils and other rodents as the rest of Ngamiland. Mr. Cairns, District Commissioner (Maun), had noticed enormous numbers of rodents in the road at night during the winter. A few weeks before we covered it he had noticed none. On our journey one small rodent was seen per mile for short stretches only in the vicinity of Rakuku and the Mababe Flats. Between Tsotsorogha and Kachikau (near the northern border) gerbil burrows were widely scattered, but all deserted. Between Kachikau and Kasane the picture was similar, although a few freshly-worked-out burrows were found.

On reaching Kasane we learned from Sergeant de Lorme that a dead mouse had been discovered two days previously by Mr. Crystal, Stock Inspector (Kasane). The mouse was examined by Dr. Clarke, who had just arrived from Northern Rhodesia to meet us. Although it had been in formalin, smears of the lung showed bipolar staining Gram-negative bacilli indistinguishable morphologically from *P. pestis*. As the specimen had been preserved, no cultural or biological confirmation could be obtained. Further investigations of the buildings revealed evidence of mortality. Multimammate mice were infesting the buildings, but were not particularly numerous. Some dried-up multimammate carcasses were found under a sleeper in the Government mealie store (not in use as a grain store) and several mice were gassed. Fleas collected from the rodents gassed and from the places where the carcasses had been found were collected in 2 per cent. saline and posted to Johannesburg for inoculation. They were inoculated eight days later, but the results were negative.

The Magistrate, Eastern Caprivi, was away on leave, with the result that it was impossible to make arrangements for a survey. Several points just across the Chobe River from Kazungula and Kasane were examined and a small village a mile or two upstream was inspected. There had been a marked reduction in the numbers of gerbils. There were deserted warrens around the village and partially occupied one opposite Kasane. An epizootic appeared to be still in progress at the latter point.

As there was active mortality amongst the multimammate mice at Kasane, we returned to Kachikau to determine whether the position was similar there. The population is much larger, and considerable quantities of grain are exported thence to Maun and other centres. A survey of the stores, village huts and surrounding veld revealed very little evidence of present or past rodent infestation, even in places where much grain was exposed to attack. At the Police Camp, a few miles from the village, multimammate mice were found in the Charge Office and tree-rats in the Rest House.

SOUTHERN AND NORTHERN RHODESIA.

Crossing the Southern Rhodesia boundary outside Kazungula, we followed the road to the Victoria Falls and Livingstone, accompanied for part of the way by Dr. Clarke. Gerbil burrows were patchy, but all were deserted and no sign of current occupation could be detected. No gerbils were found on the north bank of the Zambesi on the first 15 miles of the Katambora road from Livingstone to Old Kazungula.

RETURN VIA NATA TO FRANCISTOWN.

We made the return journey to Nata on the old Hunter's Road (Pandamatenka Road), leaving Kazungula on 26th December. The state of the gerbil population was similar to that seen elsewhere: the great majority of burrows had been long deserted, occupied ones being encountered only at very widely separated points. No change was detected in the Nata-Francistown section, traversed six weeks previously.

We reached the rail-head at Francistown on the afternoon of December 28 and entrained that evening for Mafeking. At Mafeking we reported to the Deputy Director of Medical Services on the results of the last stages of the survey and made preliminary arrangements for a survey, in January, of the south-eastern Protectorate abutting on the Transvaal border. In a short interview with His Honour the Resident Commissioner the findings and implications of the survey were briefly outlined.

THE PLAGUE EPIDEMIC.

HISTORY OF THE OUTBREAK.

A number of sudden deaths in the first week of October in the village of Sehitiwa, on the north-eastern edge of Lake Ngami, was the first indication of an epidemic of plague which was destined to be the largest outbreak in Southern Africa on record. Shortly after the outbreak began in the Lake Ngami area, cases and deaths from plague were discovered in the Makalamabedi area on the upper reaches of the Botletle River, about sixty miles east of Lake Ngami, and in the Rakops area, 100 miles further down the Botletle River. Some 15,000 persons were at risk in these three areas.

When the first suspicion of plague was reported the Director of Medical Services and the Deputy Director of Medical Services were on the point of making a tour of Ngamiland. Plague had not been diagnosed, but the District Commissioner at Maun had little doubt about it, and had acted on the assumption that it was plague, instituting control measures to meet the emergency. Sir Walter Johnson and Dr. Mackenzie left Francistown on 16th October with a supply of anti-plague vaccine. Investigations, first at Makalamabedi and then at Lake Ngami, soon left no doubt as to the nature of the disease; mass immunisation was put in hand, an anti-rodent staff was hurriedly got together, hut-spraying was begun, to be followed later by cyanogassing. Each of the outbreak areas was quarantined and inter-kraal movement was prohibited. Deverminisation stations were set up and the transport of mine natives through the infected areas was controlled. No suspicious illness was discovered in the vicinity of Maun or further north, nor between Lake Ngami and Mahembo, but the Medical

Officer (Serowe) who had been detailed to investigate the Rakops area reported plague there and between Rakops and Makalamabedi on the River road.

EPIDEMIOLOGY.

The epidemic was at its height in the Lake Ngami area during October, in the Makalamabedi area during October and early in November, and in the Rakops area during November and December. By the middle of November it was almost over in the two former areas, but continued sporadically in the Rakops area into March, 1945.

The number of cases and deaths reported weekly to December 26, 1944, have been combined into number per four-weekly periods in the following table (Table I) to indicate the general trend of the epidemic. Figures for Tsau (1 case) have been combined with those from the Lake area; those from Maun (1 fatal case) and from the river road to Namessane (10 fatal cases), together with others reported as from Makalamabedi, have been combined with those from the Makalamabedi area.

TABLE I.—CASES AND DEATHS FROM PLAGUE IN NGAMILAND TO DECEMBER 26, 1944.

Four weeks ending on	Lake Ngami.		Makalamabedi.		Rakops.		Total.	
	C.	D.	C.	D.	C.	D.	C.	D.
31st October ..	77	30	21	16	16	16	114	62
28th November	59	16	40	19	34	19	124	54
26th December	3	3	14	11	49	26	66	40
TOTAL ..	139	49	76	56	89	63	304	156

The number of deaths gives a more accurate picture of the incidence of plague. Many of the reports of cases (as well as deaths) were not confirmed by a Medical Officer and lay diagnosis undoubtedly included a number of cases which were not plague. This probably accounts for the relatively large numbers of cases in comparison with deaths in the Lake Ngami area.

The case mortality was probably nearer 60 per cent. than 50 per cent., as indicated in the records; a mortality comparable to that experienced in the Union, but in direct contrast to that in the only other endemic area in the Kalahari in Ovamboland. In Ovamboland the mortality rate is low and has rarely exceeded 25 per cent.

The majority of cases were of the bubonic type. There were also a number of severe cases, invariably fatal, of septicemic plague, some of which were undoubtedly pneumonic. Few of these were seen before death. The absence of violent pneumonic spread can be explained by the manner of life of the people and time of year. The epidemic took place in the summer months when the people were not crowded together. Further, it was customary to move sick people out of a hut into the open air or to let them lie under a temporary shelter. Had the epidemic taken place in the winter, pneumonic plague would have given rise to much more serious spread. It is worth noting another striking contrast with the epidemiology of plague in Ovamboland, viz., that no septicemic or pneumonic cases have yet occurred, in spite of outbreaks on almost as big a scale (e.g. in 1943). In view of the fact that enzootic plague invaded Ngamiland and Ovamboland from the same source and at about the same time (1930) by spread from the North-Western Cape, it is difficult to account for the strikingly different epidemiological picture.

The source of infection in the majority of cases was from plague-infected fleas in the huts. A few cases may have been contracted in the veld, more particularly in the vicinity of trees harbouring tree rodents, and a few may have been contracted from handling infected springhares and other larger animals, or from eating them. The majority of the fleas were without rodent hosts for much of the epidemic. During the actual outbreak multimammate mice were relatively scarce, and on the whole there was little evidence of really heavy infestation of a permanent nature in the huts themselves. It is probable that the number of mice moving within the huts

and granaries was very large at one time, i.e., at the end of winter following their rapid increase in numbers during the earlier winter months. Many of these would not take up their abode permanently in the huts themselves, but would be moving freely among the huts, within the kraals and the adjoining veld, where there was abundant harbourage in deserted gerbil burrows.

There seems to be little doubt that during the later stages of the epidemic active rodent mortality was on a small scale. It is not known how long the fleas *X. brasiliensis* and *X. eridos* (the two primary vectors) can survive without a host and still be capable of infecting. They are unable to maintain themselves for very long in the absence of rodents and cannot, apparently, adapt themselves as human parasites. It is known, however, that *X. eridos* can maintain plague, without a feed, in deserted gerbil burrows for three or four months. In Ngamiland *X. brasiliensis* is the chief domestic rodent flea, as it is elsewhere in Africa, and would be the most likely to be responsible for the majority of infections of rodents and of man in huts and their surroundings. Nothing is known of its capabilities of maintaining plague, but by analogy with other species which are efficient plague-vectors, it is more than likely that they can keep infection alive, even with a small rodent population, for some months. Such an hypothesis would account for the course taken by the epidemic.

(To be continued.)

Bronchspirometry.

This report is based on the bronchspirometric studies which were pursued at the Montefiore Hospital for Chronic Diseases, New York, during the past five and a half years. The functions and volumina of each lung may be determined separately and simultaneously by bronchspirometry. The use of a soft rubber tube, instead of the metal bronchoscope, has made the method less uncomfortable for the patient and the results more reliable. Bronchspirometry is indicated whenever an irreversible operation on one lung is contemplated in order to determine the functional capacity of the contralateral lung. It also permits the study of various physiopathological problems. No serious complication was seen in about 270 bronchspirometric examinations. The significance of the data obtained by bronchspirometry is discussed. Spirometry may give nearly normal findings in patients in whom bronchspirometry reveals extensive damage of one lung and compensatory changes in the other lung. Roentgen-ray and clinical findings do not permit definite conclusions as to pulmonary function. Pleural involvement often causes severe functional damage of the lung, whereas parenchymal lesions may have relatively little effect on pulmonary function.

During pneumothorax treatment, the collapsed lung shows the following changes: decrease of oxygen intake, minute volume, tidal air, vital capacity, reserve air and complementary air; increase of ventilation equivalent. Compensation is achieved by an increase of the oxygen intake in the contralateral lung. This is done only in part by increased ventilation; oxygen intake is further increased by a better utilisation of the ventilated oxygen, i.e., a decrease of the ventilation equivalent. The contralateral effect of unilateral pneumothorax is manifested by a decrease of the vital capacity, reserve and complementary air of the contralateral lung.

Thoracoplasty causes similar functional changes as does pneumothorax, but, on the average, these changes are less severe following thoracoplasty than those during collapse by pneumothorax and, at least in some cases, less severe than those in lungs following the abandonment of pneumothorax. Lungs re-expanded following pneumothorax treatment frequently show extensive functional impairment. Change in the patient's posture from the recumbent to the left or right side does not affect the percentage distribution of the vital capacity between the left and right lung. Attempts at "immobilising" a hemithorax by sandbags weighing up to 20 pounds (9 kg.) and by strapping with adhesive tape do not achieve a reduction of the ventilation or respiratory work of the underlying lung.

(M. Pinner, et al.: *Annals of Internal Medicine*, 22, 704, May, 1945.)

Treatment of Herpes Zoster with Contramine

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HERPES ZOSTER is an eruption composed of grouped vesicles on an erythematous plaque. It occurs in the distribution of a cutaneous nerve segment and, with rare exceptions, is unilateral. More than one segment may be involved. The eruption is due to an acute hæmorrhagic inflammatory reaction in a posterior root ganglion, and the distribution of the cutaneous lesion depends on the ganglion affected. It is uncommon for a patient with herpes zoster to communicate the lesions to others (see Cases 4 and 6). There is, however, considerable clinical evidence that herpes zoster may give rise to chicken-pox, and a common ætiological agent has been put forward for the two diseases. Concomitant herpes zoster and chicken-pox do occur in the same patient. The vesicles of herpes are identical with those of chicken-pox.

Pain seems to be the prominent feature of the disease, and, particularly in the elderly, may persist for weeks or months.

Treatment is usually empirical with local applications to soothe the eruption, and drugs to relieve pain. Judging by the varied treatments which have appeared in the literature, including Vitamin B₁, pituitrin, sera, vaccines, etc., nothing seems to have a specific action on the disease. In some cases post-herpetic neuralgia is very disabling and may require intensive physiotherapy.

As far as I am aware, Hawkes (1943) was the first to publish results on the use of Contramine in 15 cases of herpes zoster. He is also of the opinion that Contramine is efficacious in the treatment of chicken-pox.

Contramine is an organic sulphur compound with the formula:

Diethyl-ammonium-diethyl-dithio-carbamate.

It has a strong odour of burnt rubber.

In this series of cases it was given intramuscularly in doses of 0.125 gram per c.c. As there was no guide as to the number of injections required, the pain which occurred with the onset of the herpes was used as the criterion, and Contramine was given every day until the pain had subsided, with a maximum of six injections.

Contramine did not seem to prevent the full development of the lesions, as was shown in Case 5, in whom an early diagnosis was made and treatment immediately given. In Cases 6, 7 and 9 vesicles still developed after the commencement of injections.

Pain subsided rapidly and the eruption soon became dry. The average number of injections required to attain this result was three. In older people the pain seemed to last longer. Hawkes' experience is similar.