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## CONTENTS

	Page
A History of Lake Rukwa and the Red Locust <i>By D. L. Gunn</i>	1
The Life of Justin. Part II. An African Autobiography <i>Translated and Annotated by H. A. Fosbrooke</i>	19
Mining and Minerals in Tanganyika <i>By J. Spalding</i>	31
Correspondence . . . . .	38
Cumulative Index Nos. 31—40 . . . . .	40
List of Separates . . . . .	44
Tanganyika Society Accounts . . . . .	47
Treasurer's Report . . . . .	48
Report of the Committee . . . . .	49
List of Members . . . . .	51

#### EDITORIAL NOTES

We wish to apologise to our readers for the inordinate delay in producing this number of the journal.

We very much regret to record the death, since going to press, of Mr. Jack Spalding, one of the contributors to this issue.

Mr. G. W. Hatchell has asked us to express his regrets for omitting, inadvertently, to acknowledge the use made of Professor Smith's work when compiling his article on "Sea-Fishing on the Tanganyika Coast" which appeared in No. 37 of *Tanganyika Notes and Records*.

May we draw the attention of readers to a letter from Chief Thomas Marealle which appears in the correspondence pages of this issue? It is hoped that when the history of the Chagga has been written, it will be possible to publish extracts from it in this journal.

# A HISTORY OF LAKE RUKWA AND THE RED LOCUST

By D. L. Gunn

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## INTRODUCTION

The Rukwa Valley is part of the African rift valley system and lies in south-west Tanganyika, roughly parallel to Lake Tanganyika and some 50 miles from it across the Ufipa Plateau. For about 170 miles along the valley the south-western Ufipa Escarpment towers 2,000 feet and more above the level valley floor, which is itself 2,600 feet above sea level; the north-eastern Konongo Escarpment 30 miles away across the valley is well marked, but generally not more than a few hundred feet high.

Within this slot-like valley lies Lake Rukwa. Between the tree line and the edge of open water, there are extensive grass plains in which there are always red locusts (*Nomadacris septemfasciata* Serville). In some years, the locusts are too few to be easily found but in others there are huge numbers of them. In years of abundance, swarms are formed which emigrate and may start a widespread plague. In fact, the Rukwa Valley is one of two areas which are certainly outbreak areas of the red locust. There is a third—the Malagarasi Basin—which may be an outbreak area or may be of secondary importance, a place where swarms from the Rukwa multiply. It is the business of the International Red Locust Control Service to control the locusts in these outbreak areas, and thus to prevent the exodus of swarms which could start a plague of the red locust.

Water drains into Lake Rukwa from an area of about 40,000 square miles (Gunn, 1952) and there is no outlet; water loss is entirely by evaporation. It is not therefore surprising that the lake is salty (Ricardo, 1938). Moreover, mainly because of the large variations in rainfall over the catchment area, the quantity of water in the lake fluctuates very widely, not only within one year but also over long periods. This is a general feature of lakes in East and Central Africa. Even the great lakes that flow out by large rivers, Nyasa, Tanganyika, and Victoria, have annual fluctuations of up to 6 feet and the maximum level varies by about 5 feet in Lake Victoria, over 8 feet in Lake Tanganyika, and 18 feet in Lake Nyasa (Dixey, 1953).

Lake Rukwa is shallow, the maximum depth recorded in the south lake in 1936 being 11 feet (Ricardo, 1938), though G. R. Savory had reported for 1934 one sounding of 28 feet (Swynnerton, 1946) and Swynnerton himself recorded 14 feet in January and 9 feet in November 1946 (Swynnerton, 1946). The general depth of the more extensive northern part of the lake was 6–9 feet in October 1936 (Ricardo, 1938). Swynnerton (1946) estimated the rate of evaporation in 1946 at 5 inches per month or 4 million tons per day. In most places, there is no sharply marked edge or bank and the ground slopes exceedingly gently; consequently changes in depth of water produce very great changes in the extent of the water and corresponding but inverse changes in the extent of the grass plains. Since it is in

these plains that the red locusts live and breed, the area available to the locusts varies greatly. While there are many factors that affect the numbers of the locusts, the extent of the area in which they live is surely one of them. Consequently it is worth while looking for a correlation between lake levels and locust populations.

The difficulty is that only scraps of information are available. Because of the absence of any permanent shore line, especially in the north lake, it is not possible to measure such widely varying levels on a simple post. Even since 1941, when the Service began to operate, there are no systematic measurements of lake levels and only general indications of locust population levels. This article summarizes the information so far assembled and I hope that it will call forth other fragments which may help to complete the picture.

There is some awkwardness about the limits of the year in these matters; the calendar year is generally unsuitable because the natural break occurs at the end of the dry season, which is not at the end of the calendar year. Shortly after the rains begin, usually early in November, the locusts begin mating and, a week or two later, laying their eggs in the ground. The first hatchings generally occur in December and the first adults in February. One has therefore to speak of, e.g., the 1944-45 rains, the breeding season being similarly specified, and the 1945 dry season. Some writers do not do this, but refer to the 1945 rains and breeding; this has usually been found to mean the rains and breeding which produce their largest effects at the beginning of the year named. Confusion regarding years can also arise because the administrative year has at various times begun in January, April, and July, so that great care is needed in quoting from Annual Reports if mistakes of a year are to be avoided. When referring either to lake levels or to locusts, it is usually necessary to mention the month as well; Swynnerton (1946) has shown that the open water surface can fall by 5 feet in one dry season (January-November, 1946), which may reduce its area by scores or hundreds of square miles, while there are never any locust swarms in January, because most of the old adults have then died and the new generation has not begun to show its wings.

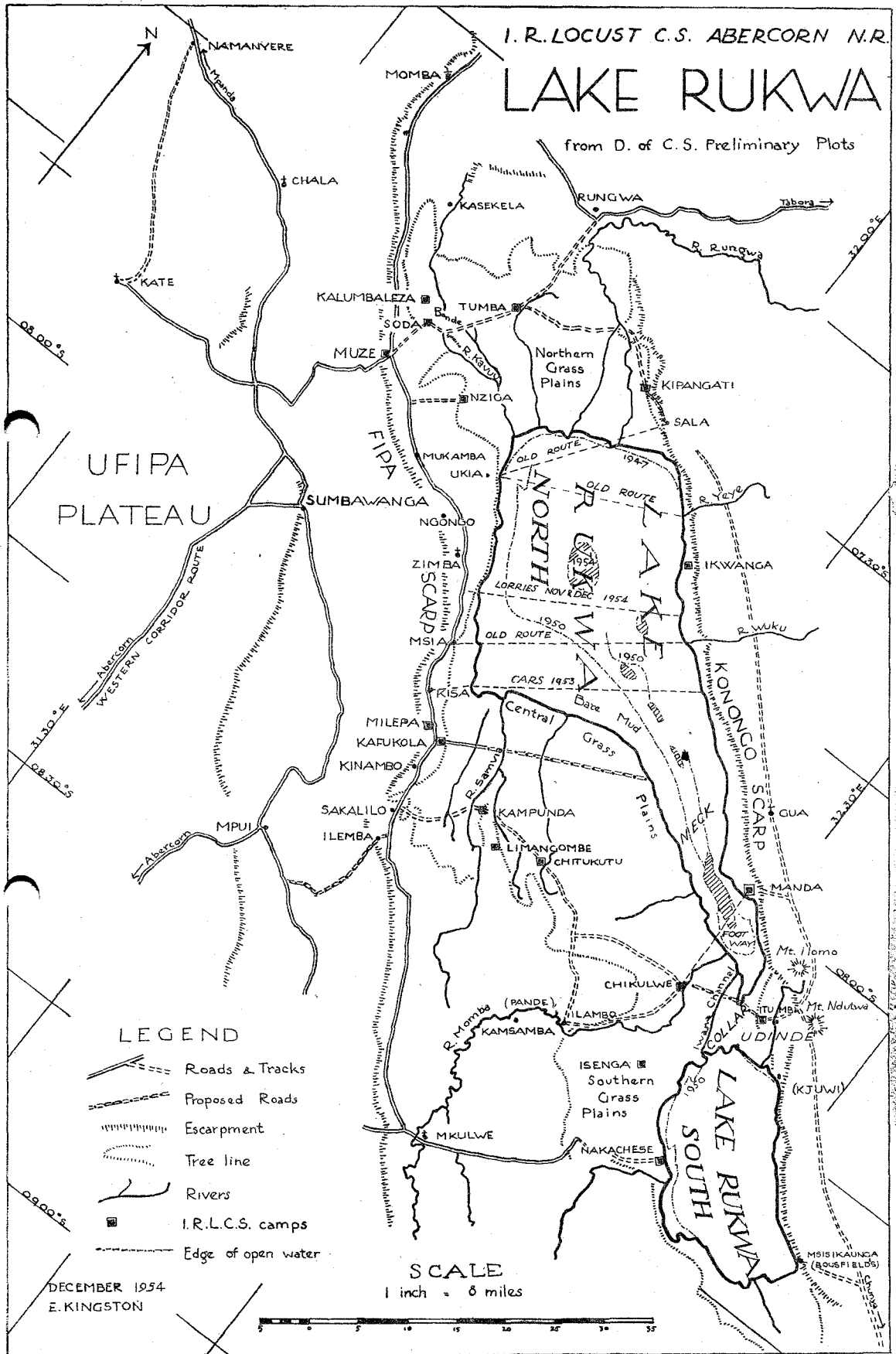
#### LAKE RUKWA IN 1947 AND 1950

In July 1947 for the north-western shore and May and June 1950 for the remainder, aerial photographs of the region were taken and the Directorate of Colonial Surveys has made maps from them on a scale of 1 in 50,000. These record the extent of the lake at those times. Unfortunately it is not always easy to interpret such photographs. For example, it is only too well known to members of the Red Locust Service that, when the lake is fairly high, one may have to walk hundreds of yards or even miles through grass in water, before reaching open water. The true edge of the continuous water surface is concealed in the photographs in luxuriant swamp. Similarly, when the lake is low, it may be necessary to traverse miles of soft mud, impassable to vehicles, before reaching open water or even knowing if there is any. Then only aerial photographs or reconnaissance can in practice determine the extent of open water. Even so, it is usually difficult to see where grass ends and bare mud begins. Nevertheless, the maps from aerial photographs are, in spite of some disadvantages, the most accurate ever made to show the lake.

I. R. LOCUST C.S. ABERCORN N.R.

# LAKE RUKWA

from D. of C.S. Preliminary Plots



UFIPA PLATEAU

NORTH LAKE RUKWA

LAKE RUKWA SOUTH

### LEGEND

- Roads & Tracks
- Proposed Roads
- Escarpment
- Tree line
- Rivers
- I.R.L.C.S. camps
- Edge of open water

### SCALE

1 inch = 8 miles

DECEMBER 1954  
E. KINGSTON

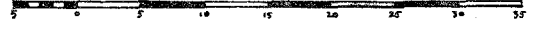


Figure 1 is a reduced copy of the relevant maps, showing also the places mentioned in the text. Villages are moved from time to time and spellings of names vary, but the figure will serve the purpose.

The Colonial Survey Preliminary Plot Maps are highly reliable and detailed for the area that they cover, but they do not yet cover the north-eastern shore of the lake, nor its southern end. Generally speaking, the valley is a little deeper near that shore, with the result that the grass plains are much narrower there and locust populations are generally insignificant. Consequently little attention has previously been paid to that shore. But with the drying out of the north lake in the past few years, the grass has extended miles into what was previously lake-bed and a serious locust infestation extended 25 miles along the coast in 1954. This involved the Service in extra work in a region that had not been mapped for half a century, that had no roads and no villages, and that was largely unknown.

Maps were made by the early explorers and their principal features were form-lines of hills, named rivers, and named villages. But about 25 years ago, because of sleeping sickness, Dr. MacLean concentrated nearly all the small villages into the two big groups at Rungwa and Udinge, leaving only Manda and Sala in the 80 miles between. Consequently the village landmarks are gone and there is nobody to tell the names of the rivers in the valley. On the plateau, there is a good road from Chunya through the Lupa Goldfield area to Saza Mine, with connections to Bousfield's on the lake shore, to Udinge (Uleia, Isosha, Itumbi and Iteka villages) and on to Gua. From Gua a track runs parallel to the valley; this was made solely for getting timber and its many branches end blindly, one of them only about 6 miles from Sala. I once drove by car the whole day from Gua along these tracks without meeting a single human being and had eventually to sleep in the forest. The high frequency of tsetse fly was a sufficient explanation of the lack of inhabitants or travellers.

Because the old maps show features of the Konongo escarpment area which are inaccurate and now difficult to identify and because the new Colonial Survey maps do not cover the area, Fig. 1 does not show many features there and is not reliable for Konongo. The old tracks across the northern end of the lake are also difficult to place reliably.

#### HISTORICAL INFORMATION ABOUT LAKE RUKWA

The earliest reference to the Rukwa Valley is found in Livingstone's last journals (Waller, 1874). From this and from modern knowledge of the locality, it is clear that Livingstone's body was carried across the valley on the journey from Northern Rhodesia to the Tanganyika coast. From Lambalamfipa "looking down on the plain . . . a vast lake appears . . . but on descending this resolves itself into a glittering plain, for the most part covered with saline incrustations. The path lay directly across this" (Vol. 2, Chapter 13, 1st Ed., p. 335).\* Reference is also made to the Likwa River, breast high with brackish water, and to a salt-water lake on the right (south). That is to say, the crossing was made to the north or north-west of the north lake, which was evidently low, as indicated by the salt that was collected. On the other hand, it was not an extremely dry period like 1954, for there was breast-deep water in one river, probably the Rungwa, in the plains close to the lake, for it was salty. This was in September or October, 1873.

\*From the account by Livingstone's servants, Susi and Chuma, who escorted the explorer's remains to the coast.—Ed

The first European to see Lake Rukwa was Joseph Thomson (1880, 1881) who walked from Makapufi near the present District Office at Sumbawanga and looked down on the northern part from the Ufipa Escarpment on 27th April 1880, probably near Ngongo; but he did not descend. It seemed to him that he could throw a stone into the lake, for it seemed close to the escarpment. There is no place where he could in fact have done so, for the escarpment itself is by no means sheer, but evidently there was enough water in the northern part of the lake for us to presume that it was at or above average level.

On 5th October 1882, Dr. Emil Kaiser (1883) reached the lake shore some 500 metres east of the village of Ukia; he died there two weeks later. He recorded that the water level was unusually high, for a tree stump was sticking up out of the water. In November 1889, Sir Harry Johnston and Dr. D. Kerr Cross approached the southern end of the lake and reported that the area had had no rain for two years (Johnston, 1890). Cross went on to the water's edge and thought its area had been much reduced from previous years (Cross, 1891). He stated that no "intelligent visitor" had seen the lake between 1882 and 1889. The famous von Wissmann, later Governor of the territory, crossed the southern part of the valley in July 1893 but commented only on locusts, lions, and the general dryness, not on water levels (v. Wissmann, 1893). Nutt (1896) entered the valley from the west, probably by the Ilemba route or thereabouts, and turned south in mid-1894. He, too, mentions that the people were in want because of locusts and he describes the lake, saying that it ended northwards at Mt. Mbutwe. If this is the same as Ndutwa, which is a landmark east of the collar, the implication is that there was at that time no northern lake.

Early in 1897 (January-February), Langheld (1897) visited Ukia and carved Kaiser's name on the baobab tree beneath which he was buried; he reports the natives as saying that the lake began to go back some six years previously. Although he could see no water, with glasses he could make out large flocks of birds, so there must have been some water within a few miles; that would not be unexpected in mid-rains.

Sir Lawrence Wallace went right round the lake in August 1897 (Wallace, 1898; Boileau and Wallace, 1899). He crossed the bare lake-bed from the north-eastern escarpment to Ukia, so the water level must have been low, at least; but he was told that there had been much less water three years previously and he discussed Nutt's visit to give the same conclusion. He went ankle deep in the swamp water of the north lake at Puani, some 40 miles north-west of Chiubi (Kjuwi), but saw no open water there or anywhere except in the south lake. Ramsay (1898) was at Ukia too in November 1897 and described a *chikulwe*, the great cloud of salty dust that blows off the lake-bed when it is extensively dry. That ends the period of preliminary exploration.

According to Ramsay (1898) and Schnee (1920) the water level fell progressively from 1883 until about 1890, but from Cross's statement it appears that this was based on interpolation between the scanty records or upon evidence later collected from the local people. According to Meyer (1909), who quotes Ramsay, the north lake extended again from the middle nineties until, by 1899, it was 80 Km. (50 miles) long. But there appears to be no solid evidence of any great extension by the end of 1897.



After this and in the late nineties, several scientists visited the valley; Dantz, a surveyor or geologist; Goetze, a botanist; von Prittwitz, a geographer; Fülleborn, who collected fish, in December 1899; and Glauning, who was measuring the force of gravity at Kamsamba on the Momba River, in July 1899. One or other of these men walked straight across the lake-bed from Msia, showing it to have been very dry, from Pande on the River Momba to Manda across the neck of the lake by a route which is still used when there is not much water, and from Pande to Uinde (Sprigade, 1904). This last route did not go straight across the Collar, but northwards and then eastwards, so that it missed the very rough ground of the Collar and remained on the plains or on old lake-bed. Dantz (1903) went by the customary route to Manda, but started from Ssenga (Isenga?), "on the Momba River". This was after the rains had started on 22nd November 1899 and he called the plain a low grass steppe, not a lake or even a swamp. Von Prittwitz visited Kjuwi (at the north-east corner of the south lake) in October 1899 and at exactly the same day of the same month in 1901 and he recorded that the water was 2-3 metres higher on the second visit (Sprigade, 1904). By 1904, the water at Ukia was as high as when Kaiser died there in 1882 (Meyer, 1909). Sprigade's map (1904) shows these traverses of the bed of the north lake and also shows the Momba River as flowing into the south lake.

By 1904, investigation of the area seems to have ceased and in that year was published the German map (Sprigade, 1904) which has been used for all subsequent maps until the appearance of the modern D.C.S. products. The older maps were based on the observations of the travellers mentioned above, which were summarized by Langhans (1899). The north lake thus appears as "dry bed of former lake" or "old lake bottom; under water again since 1904 as far as Ukia". These maps generally show the "road" from Bismarckburg (now Kasanga) passing via Sumbawanga, Ngongo, and Ukia, then straight across the valley, and on to Kilimatinde; this crosses a part which has since been open water and it seems likely that before such a route would be established, not only would the lake level be low but it would have been low for some time. It is therefore fairly clear that there was a prolonged dry period from about 1889 to about 1900, followed by rising water up to 1904 or so.

British civil administration of the area began about 1921. For the period from 1904 to 1936, no published observations on lake levels have been discovered. The annual reports of the German districts are not in the official archives at Dar es Salaam and cannot be found; the annual reports of Ufipa District since 1921 do not mention lake levels until 1937. This is a very serious gap, for it was in 1930 that the last locust plague began, partly from the Rukwa Valley.

Some local information has been collected from a locust scout, Mateo Katandula at Milepa, who was probably born about 1887. He says that the north lake was very high about 1905 and very much higher in 1937; it then reached the trees near Milepa, even flooding the Kapalala plain between Milepa and Kafukola. It did not go down much until 1942 (Albrecht, 1952). He thinks the lake was dry about 1920 and 1949. The annual reports of the District Commissioner, Sumbawanga, state that in 1937 the lake was 12 feet above its 1935 level and was still very high in 1938. In these two years, Lake Nyasa and Lake Tanganyika were also abnormally high and it was a period of maximum numbers of sunspots (Dixey, 1953).

Mateo's memory has thus been confirmed for about 1905 (in which the water may have actually been higher than in 1904) and 1937, while 1949 is well remembered by many of us. He may therefore be right about the dryness of 1920. The White Fathers at Zimba recorded an exceptionally severe drought in Rukwa in the wet season 1919-20; Lea and Webb (1939) quote a White Father (Bigot) as stating in 1936 that the north lake was quite dry in 1920 (p. 73).

Monson (1936), a journalist who walked from the Cape to Cairo, was turned aside at Sumbawanga because of the sleeping sickness further north; he went down the escarpment and south-eastwards across the Momba River to Mbeya in mid-March 1929. He did not report directly on the lake level but said the region was drought stricken and that the rains which had been due in October "had not fallen". The account is perhaps somewhat dramatized. He also says that "the natives had been without food, save fish from Lake Rukwa, for several months". The local people are in fact improvident and are often short of food before the new harvest is gathered. Swynnerton (1946) quotes the White Fathers at Zimba Mission as saying "the north lake filled up again during the heavy 1929/30 rains. At this time the north and south lakes were separated by a long bar of dry land, but by 1935 their waters had joined again". This suggests that the north lake was empty or low in 1929 and tends to confirm Monson, but the year has not been mentioned as exceptional by Mateo.

A. P. G. Michelmore first entered the valley with Victor Harris in November 1933 and saw from above Ngongo "a great stretch of open water instead of a swampy old lake bottom" which the maps had led him to expect (Michelmore, 1937). Thus at the end of the dry season, there was no great expanse of grass or dried mud between the trees and the water, so the north lake must have been fairly full. Michelmore also quotes local statements that the lake was deep in April 1934.

As far as it goes, therefore, the evidence seems to show that the lake was dry in 1920, at a low level by 1929 and filling up in early 1930, but not to the very high level of 1937. By the end of 1933 when Michelmore saw the lake, it was fairly high, and it also seems to have been deep in 1934. In 1935 it was deeper still, especially over the Collar, and, though it went down somewhat in 1936 (Swynnerton, 1946), in 1937 it rose to unprecedented heights. There is no evidence of prolonged low levels in the decade after 1930, but quite the reverse; but the more interesting period is before 1930 when no contemporary records were kept. It would be specially valuable to receive reliable information about the period up to 1933.

In 1936, the late Major R. A. Bousfield dug and dynamited a passage from the southern to the northern lake. This channel was later enlarged by the natural flow of water (Swynnerton, 1946) and may be what is now called the Iwana Channel. Bousfield used this route to go by motor boat from his house at Msisikaunga, near the south-east corner of the southern lake, to Zimba; he took Miss Ricardo there in 1936 (Ricardo, 1938). In June 1940 he wrote to the District Commissioner, Sumbawanga, that "the depth of water now left in the junction of the two lakes is only about 24 inches;" he ceased to use the route much at that time.

The decade beginning in 1940 was broadly one of increasing dryness, though not uninterruptedly so. The water began to recede from Milepa in 1942 (Mateo) and by October 1944 the plains had extended considerably (Michelmore, filed

report). In late 1944, the south lake was low; the Bousfield family tell me it ranks only after 1949 and 1954 for low level. Nevertheless Mr. Roy Forrester tells me that in late February 1945 a locust officer, Mr. B. W. Christowitz, went by Major Bousfield's boat from the south lake to Ukia; but no boats did the journey after that year because of continual bumping on the bottom. In late 1945, the Bonde ya Kavuu was dry and a motor track from Kalumbaleza was used to cross the valley. The Bonde ya Kavuu is a great bowl, into which the Kavuu River empties and from which the same river then has a channel to the lake; it may thus be dry when the lake is moderately high or it may be impassably wet when the lake-bed itself can be traversed by vehicle, as in October 1953. In January 1946 there was so little water in the plains that wells had to be dug, although the rains were on. Vehicles were used in the plains in February 1946. The camp near the water hole at Nziga was flooded out early in 1947, so that wet season seems to have checked the drying out somewhat. The year 1948 was described as less wet than usual and the District Commissioner, Sumbawanga, reported deaths of hippos in north Rukwa. In both 1948/49 and 1949/50 the local rains were poor. In 1949 the south lake shrank extraordinarily and stopped the fishing; and as early as February Mr. Bredo recorded that the north lake was nearly dry. In 1950, when the south lake was not so low, the water was only ankle deep and a mile wide in the neck of the lake on 6th June (Mr. Vesey-FitzGerald) and later a vehicle was driven across the neck by A. C. van Dyk. The decade was therefore, broadly speaking, a period of increasing dryness.

The inflow of water in 1951/52 was fairly high, causing extensive flooding of the northern plains which lasted until October 1952, but the lake did not rise particularly high. The Bonde ya Kavuu filled up, covering up a banked track from Soda to Tumba that had been made in early 1949. The Bonde could not again be crossed until 1954 and the road was re-opened in May of that year. Although the Bonde remained wet, the north lake was drying up extensively in 1953.

Michelmore was in the valley in every year from 1933 to 1945 except 1939-1940. H. A. F. Lea was there in 1936-37. Both of them visited their old experimental area as members of the Council of the International Red Locust Control Service in July 1953. They agreed that the grass plains had never been even nearly so extensive in their time as in 1953. For most of the dry season, the bare, dry, lake-bed was used by vehicles going from Milepa to the collar. In September the neck could not be crossed by vehicle, but on 11th October, Mr. I. A. D. Robertson reported that, accompanied by Messrs. Forrester, Beesley, and Horn, he had driven across the neck to the north-east escarpment. On 27th October with almost the same party, I was prevented by mud from crossing the broad part of the north lake near Zimba, but was able to cross opposite Kisa.

The 1953-54 rains did little to fill the north lake. On 26th March 1954, when the rains would not normally have ended and water levels would be almost at their highest, my wife and I drove on the dry lake-bed from near Milepa to a point 14 miles due east of Zimba. On 26th May, aircraft reconnaissance by Mr. Frank Gillman showed elongated pools of water in the neck and extending towards the northernmost point of the north lake, but very extensive dry areas. In August, Mr. Roy Forrester dammed the Iwana Channel and put a track right across the Collar to Udinde. On 4th November, I drove square across the north lake-bed at its widest place, from about 4 miles south-east of Zimba to about 3 miles north-west of the Wuku River. Lorry loads of materials followed across this route in

the next few days, for there was an unprecedented locust infestation on the north-east side, and the route was used into December, after the rains had begun. From being a few hundred yards wide, the grass plains on the Konongo side had spread up to 4 miles into the former lake-bed. On 11th November 1954, aircraft reconnaissance showed that there was no water near the western shore between Zimba and Ukia, where it normally lies long, though there was dark and therefore damp mud. This provides the only detailed information to the effect that the north lake contained no water at all. On previous dry occasions, no such extensive investigation was possible.

From these facts, two periods of extreme dryness stand out, namely the 1890's and from 1948 to 1954, the latter relieved by the 1951-52 wet season. Three periods of deep water are known, namely about 1882, 1904 and 1937. The last wet period declined only slowly and it is also evident that it built up slowly, for there is evidence for every year from 1933 to 1937 that there was by no means a dry lake. Apart from these clear results, it is also possible that the water was very low in 1920 and low in 1929.

TABLE 1  
WATER LEVELS IN LAKE RUKWA

Date	Lake levels	
Before 1873	Unknown	—
1873 Sep. or Oct.	Medium or low	Waller 1874
1880 April	Fairly high	Thomson 1880
1882 October	Very high	Kaiser 1883
1883-1888	Unknown	—
1889 Nov.	Low	{ Johnston 1890 Cross 1891
1893 July	Low	v. Wissmann 1893
1897 early	Very low	Langheld 1897
1897 Aug.	Low	Wallace 1898
1897 Nov.	Very low	Ramsay 1898
1898 ?	Dry	Sprigade 1904
1899	Dry	Dantz 1903
1899 Oct.	Low	v. Prittwitz
1901 Oct.	Much higher	v. Prittwitz
1904	Very high	Meyer, 1909
1905	Very high	Mateo (Albrecht, 1952)
1906-1919	Unknown	—
1920	Dry	{ White Fathers Mateo
1921-1928	Unknown	—
1929	Low	White Fathers
1930	"Filled up"	White Fathers
1933 Nov.	Fairly high	Michelmore 1937
1934 Apr.	"Deep"	Michelmore 1937
1935	"Deeper"	Swynnerton 1946
1936	"Went down"	Swynnerton 1946
1937	Very high	{ D.C. Ufipa Lea and Webb, 1939
1938	Very high	Michelmore, <i>in litt.</i>
1939-41	High, falling	Bousfields
1942	High, falling	Mateo
1945 Feb.	Still high enough for boat in north lake	Forrester.
1946	Medium ?	} I.R.L.C.S. records.
1947	Medium ?	
1948	Low	
1949	Dry	
1950	Dry	
1951	Fairly dry	
1951/52	Floods in plains	
1953	Dry	
1954	North lake entirely dry	

### THE LOCUSTS AND THE RUKWA VALLEY

The first locust plague which can definitely be attributed to the red locust was recorded in Natal and Zululand from 1847 to 1854; there is no evidence of where it originated. In the same regions, the second plague lasted with fluctuations from 1892 to 1910 (Faure, 1935). It was recorded in Nyasaland newspapers at the end of 1893, though there may be some confusion of details with a plague of the West African Migratory Locust (*Locusta migratoria migratorioides* R & F) which started just before (Smee, 1940, 1941). Although Europeans were by this time occasionally visiting what we now know to be red locust outbreak areas, the existence of the plague of the other species of locust makes their references to unspecified "locust" swarms of little value. If this second plague did originate in the same outbreak areas, it probably began about 1889, a year when only one of the outbreak areas appears to have been visited, the South Rukwa; neither Johnston nor Cross provided any useful information about locusts. Their statement that there had been "no rain" there for two years does not suggest suitable conditions for successful locust breeding, but we now know that the region that they visited often has much less rain and more famine than Central and, more particularly, North Rukwa. This plague was certainly widespread in eastern Africa (Harris, 1933).

After the end of the second plague, the next information comes from the White Fathers' Missions, through the courtesy of Mgr. J. Holmes-Siedle, Bishop of Karema. In April 1913 a swarm settled at Mamba Mission and in October 1914 another came to Zimba Mission, both in the Rukwa Valley. More significantly, in July 1914 an immense cloud of locusts arrived at Kate on the Ufipa Plateau. Inquiries by Father Aarden showed clearly that these were red locusts (*Chifipa-mbalazi*) and not *Locusta (kitwekoko)* which was recognized by the "hair on its chest" and remembered from about 1890. Then there were red locust swarms in Uganda in 1915-1918 (Johnston and Buxton, 1949). The Abercorn District Annual Report for 1920-21 also refers to occasional red locusts which caused no damage, and Father Bagot remembered "plenty of locusts" in the Rukwa in 1920 (Lea and Webb, 1939). It is thus possible that a small plague originated in Rukwa in 1913 and died out in Uganda in 1918, but it is also possible that the Uganda plague began in the Malagarasi Basin. The 1920 reports may refer to an independent upsurge.

The next reports are from Chala Mission of the White Fathers, on the Ufipa Plateau, referring to 17th May 1922 and 20th June 1926. During this decade, there may often have been swarms within the Rukwa Valley. The Ufipa District Annual Report for 1925 reviews the possibilities of agricultural development and mentions the failure to establish the cultivation of cassava in the Rukwa "owing to the attacks of the locusts"; this may have been part of the prolonged resistance of the natives to adopting cassava, which is now an important famine-prevention crop in Rukwa. But in the same report, reference is made to locusts appearing on the plateau in August 1925. Harris (1933) mentions reports of swarms in the valley in 1926. It seems likely, however, that there was a considerable incidence of locusts at least inside the Rukwa and possibly on the plateau; which did not seem exceptional to those who knew of it and so passed unrecorded (see Harris, 1933, p. 3). The Ufipa Annual Reports record one swarm at Rungwa Village on 29th March 1930 and a small number of swarms in 1931, but the first page of the Annual Report for 1932 asserts that "Locusts, of course, we have always with us

and a great deal of damage was done to malezi crops." A letter dated 18th September 1931, from the District Commissioner, Sumbawanga, to the Provincial Commissioner, Kigoma, says "as you are aware there is little doubt that locusts have been breeding in the Rukwa area for the last 3 or 4 years without any report being rendered".

Although red locusts breed every year at very low densities in hundreds of places scattered over Africa, there is no evidence of swarms originating outside a very small number of places; swarms may give rise to swarms outside the outbreak areas, but the first swarms arise from sparse populations of parents in outbreak areas. It therefore seems likely that the Ufipa swarms of 1922, 1925, 1926 and 1930, were the result of specially successful breeding in the Rukwa in the immediately preceding rainy seasons. The absence of definite reports for 1927-28 may be fortuitous, but it may mean that breeding had been less successful in those years. The Annual Report for 1929 says there were no swarms on the plateau in that year.

By 1931, the third major plague was well under way, having probably begun in 1929 by a few swarms from Mweru wa Ntipa in Northern Rhodesia, supported by the Rungwa Village swarm from Rukwa in early 1930 and by others which were reported on the Ufipa Plateau in April, July and August (Harris, 1931). The third plague went on until 1944 (Morant, 1947).

In 1933, Michelmore first arrived with Harris in the Rukwa Valley. From then onwards, information about locust swarms was increasingly sought and systematically recorded. At first, the organization was minute and the information that survives is sketchy and difficult to interpret. Up to 1930, reports of swarms in or near the Rukwa Valley may be taken to indicate the years in which breeding in the valley had been successful; but, after 1930, two complications make such assumptions less certain. First, once the plague began, large-scale breeding occurred not only in the valley but also on the Ufipa Plateau and eventually over an enormous area. Very detailed reports are necessary before one can assign a breeding place to a particular swarm and one can in fact seldom do so. Second, from 1942 onwards, the locust hoppers were destroyed to an increasing extent in the Rukwa; consequently the absence of reports of swarms may mean that breeding was poor or that control was good. In order, therefore, to be able to correlate locust reports with lake levels and other conditions affecting breeding, much more detailed information is required after 1942 than before.

The plague itself has been described by Morant (1947); it was not uniformly severe in every year or in every place. The Ufipa Plateau was badly affected, with crop damage, in 1933-35 and in 1939-40, but by 1942 Ufipa was "free from the attention of locusts". During this period, Lea and Webb worked in Central Rukwa (February 1936-May 1937). Michelmore had reported a 15-mile long swarm from Kinambo to Msia in November 1933, an invasion of swarms from the south in early 1934, and a swarm going up the escarpment in August 1935, but Lea and Webb (1939) record no swarms of that character. In most of the North and Central Rukwa, a walking man saw zero to three locusts per hour, but near Kalumbaleza there appears to have been a swarm that could not be re-discovered, while there was a static concentration of 200 acres in Central Rukwa. In certain experimental plots at Milepa, the *average* number of locusts flushed was 60 per 100 paces over nearly 2 miles, a density which we should nowadays regard as likely to become dangerous after further breeding. In most of the Milepa-Kampunda

area, however, only 200–500 locusts were flushed per hour (say 4–10 per 100 paces). In a letter to the Anti-Locust Research Centre dated 11th March 1944, Michelmoresaid that Central Rukwa, according to all native reports, had been free from swarms between 1938 and 1942, though North Rukwa may not have been. As far as the evidence goes, therefore, while the plague was in full swing the breeding in Rukwa itself had been rather unsuccessful for a number of years, in the late 1930's.

In 1941, Michelmores began the Red Locust Control Service. No substantial field work was done in that year, but a slender scouting and reporting system was set up in 1942. Plague swarms still occurred on the Ufipa Plateau. In October 1943, Abercorn, the Ufipa Plateau, and the Rukwa Valley were invaded from Rhodesia. This was the last plague movement in the region.

Inside the valley, 1941–42 was a poor locust year for Central Rukwa. From then until 1945, Central Rukwa can hardly have produced many locusts, for although almost the only control was by beating, which is most inefficient, no migrant swarms were reported. It is noteworthy that in both 1942–43 and 1943–44 it was only the Limangombe area of Central Rukwa that gave some trouble, an area that has in recent years been far from the lake shore and almost free from locusts.

The situation in North Rukwa was different. Heavy breeding was reported in the Kavuu delta in 1941–42, leading to swarms that milled about near Kalumba-leza, while some emigrated to the north and west. No detailed information is available about the 1942–43 breeding, except that control was by beating and was completed in four weeks, but in 1943 came a Rhodesian swarm, which probably affected mainly South Rukwa. The following breeding season produced populations at swarm density which, however, remained sedentary in North and Central Rukwa. At the end of 1944, Michelmores wrote "the plain has dried up to a large extent and locusts are in great numbers, the danger of swarms forming unmolsted is a serious one" and he suggested mechanizing control.

The 1944–45 rains produced early flooding in Central Rukwa and seem to have largely destroyed the eggs in the ground. But in North Rukwa hatching started on 4th December and it was evident in the new year that there was a most serious outbreak east of the Kavuu. Some 370 beaters produced little impression on it and by mid-February 150 square miles were reported heavily infested. Warnings were issued and during 1945 between 50 and 100 swarms emigrated from the North Rukwa (Michelmores, 1947).

The dry season of 1945 saw tremendous activity in the Rukwa Valley to suppress any further outbreak (Bredo, 1947). In the previous year Bredo had had about 2 tons of bait in Northern Rhodesia and Michelmores had had about 5 tons for his unaided use; in 1945 some 550 tons were brought in along specially made roads and 13 Europeans were employed. Not only this bait, containing 10 tons of sodium arsenite, but also a sample consignment of BHC was entirely used up, mostly in North Rukwa. The killing went on until the end of March and although there were reports of swarms in the valley in early 1946, there was reported to be no danger of any emigration. The combination of a very big parental population and a very large control effort makes it difficult to assess the success of breeding; it was probably fairly good.

Nothing is known about what happened to the emigrant swarms of 1945, but it was suspected that some returned to Rukwa and some bred near Lake Katavi. In 1929 and 1930, it seems to have taken only a few swarms to start a 15-year plague, while in 1945 the big emigration seems to have led to little, possibly only to an upsurge that occurred in Malagarasi in 1947.

The 1946-47 rains led to extensive early flooding, so that camps at Nziga and Katwa Makondo had to be abandoned. Just before the rains started, a large swarm flew westwards across the North Rukwa to Mukamba and laid eggs, not in the grass plains but in the fringing forest, for many miles towards and beyond Milepa. At the time, it was suggested that this swarm came from outside the valley; there had been no swarm reports from that direction for some years, but the region is almost uninhabited. With the extra knowledge that we have today, however, it seems much more likely that it came from the eastern North Rukwa itself, near Kipangati, as swarms have done several times since. If that is correct, it was composed of survivors from the great 1945-46 campaign. However that may be, by April and May 1947, half a dozen swarm reports referred to the Ufipa Plateau, later in the year one was in Abercorn District, one swarm of 1,500-2,000 acres was repeatedly reported near Namanyere on the plateau, and 3 swarms were reported near Uruwira. It was in that year that the first systematic attempts were made to attack adult locusts, aircraft spraying being shown to be effective but expensive (Gunn *et al.*, 1948) and dusting by a light machine on a truck to be ineffective. Widespread investigations revealed no swarms further afield, but clearly 1946-47 had been a good breeding season in the valley.

The 1947-48 breeding season was complicated by the immigration of a swarm from the plateau; it was seen to descend the escarpment near Mukamba and divide to North and Central Rukwa. After the hopper destruction was over, there were concentrations of locusts in 1948 in both these areas, but no swarms. The first heavy spraying machine was used against these adult locusts. The following rainy season began the first real drought year and breeding was so poor that the labourers were employed on making an embanked road from Soda to Tumba in early 1949. It looked as if the locusts had ceased to be troublesome.

The season 1949-50 was also one of low rainfall but the breeding was highly successful in both Central and North Rukwa. In mid-April 1950, the Chieftainess of Sakalilo, Mwene Maria, reported swarms damaging crops at Milepa. Only one small swarm got out of the valley; that reached the Lusanzi ledge on the escarpment above Ngongo in August, was immobilized by cold, and eaten by the local villagers (Albrecht, 1950). It was in 1950 that, for the first time, there were extensive operations against adult locusts in the valley, in both North and Central Rukwa, and it was in that year that mechanization of control began.

The 1950-51 breeding season was reported to be heavy but the resulting adult population was small; some swarms of adults were destroyed and possibly would have emigrated if they had been left alone; none remained by September. The heavy rains of 1951-52 deeply flooded the Iku plain and caused floods in North and Central Rukwa that lasted nearly to the end of the 1952 dry season. A considerable adult population was left, in North Rukwa especially, but it remained static, possibly because of the damp conditions.



The wet season 1952-53 opened in early November with widespread heavy rain and the locusts laid their first eggs. Then there was a dry period lasting until after Christmas; practically all these first eggs died by drying in Central Rukwa and many of them in North Rukwa too, so that 1953 saw reasonably low adult populations. It was noteworthy, however, that breeding had occurred in 60 square miles of *mpangali* (*Sporobolus robustus*) grass in Central Rukwa that had previously been under the flood waters of the lake, while Limangombe, near the trees, produced no hoppers.

In 1953, the first attempts were made to estimate the number of adult locusts in the North Rukwa. The counts made then, interpreted by calibrations made by Mr. Scheepers in the following year, indicated an early dry season population of about 20 million locusts in about 300 square miles. By the end of the season, control measures reduced these to about 18 million, which incidentally, would weigh about 50 tons. This averages one locust in more than 45 square yards, a density far too low for economical attack by insecticides. The locusts were not, of course, uniformly scattered and there were still a few places where they were dense enough to attack, but the ground was too rough for the machines to operate there. The total locust population of Central Rukwa (550 square miles) was similar but was not estimated so carefully.

The 1953-54 rains were not particularly heavy but they were well distributed in the early part of the season, so that breeding was highly successful. It does not seem to have reached the highest possible rate of 100 times increase (Robertson, 1954), but it was probably about 50 times. Estimates made by Mr. J. Haydn Lloyd indicate that some 470 million hoppers were killed and a further 200 million adults by the end of May, leaving about 250 million adults. One swarm escaped from the valley in May but was destroyed by aircraft spraying not far from Namanyere. Another swarm was reported at Nyonga, 45 miles north-east of Rungwa, at the end of July but was never found again in spite of prolonged search. A third migrated from the Kipangati area of North Rukwa early in September; at least part of it was probably responsible for a big rise in population near Lake Katavi, the most northern end of the Rukwa outbreak area. In searching for the possible remainder, confusion was caused by the extension of the current desert locust plague as far south as Nyonga and by a plague of the small grasshopper *Faureia* originating in Ruanda-Urundi; many reports of these two species were investigated, but no migrant red locusts were found. Further control by both aircraft and ground machines reduced the population in the Rukwa still further to about 190 million by the end of August and to about 60 million by November 1954, when the rains began. The control service had, after a most arduous year, reduced the rise of 50 times to about 3 times the population of November 1953. There is little doubt that but for the effectiveness of control, many swarms would have emigrated in 1954 and the 1953-54 breeding season must be regarded as highly successful in the North Rukwa. In the Central Rukwa it was also rather successful, especially in places remote from the trees which would, in wetter years, be submerged in the lake edges; but no such detailed assessments of population were made there. The 1954/55 breeding season was very successful in North Rukwa and the Collar; the rains were not heavy and although some water entered the north lake from the River Rungwa and from the south lake, light vehicles were used to cross the valley near the north-western edge of the lake bed as late as March 1955.



Swarm of Red Locusts (*Nomadacris septemfasciata* Serville) near Rungwa Village in the Rukwa Valley of south-west Tanganyika on 20th March 1955. This is the earliest date in the year at which a swarm is known to have emigrated from the grass plains of the outbreak areas, the previous earliest being 29th March 1930, at the beginning of the last great plague. The 1955 swarm was destroyed by aircraft spraying by I.R.L.C.S. in the few days following.

Photo: D. Vesey-FitzGerald.

TABLE 2

LOCUSTS IN THE RUKWA VALLEY AND OUTSIDE

1847-54	...	...	Plague in South Africa. Origin unknown.
1892-1910	...	...	Plague in South Africa. Rhodesia and East Africa. Origin unknown.
1913	...	...	Mamba.
1914	...	...	Zimba, Kate (Ufipa Plateau).
1915-18	...	...	Plague in Uganda only.
1920	...	...	Abercorn.
1922	...	...	Chala (Ufipa Plateau).
1925	...	...	Ufipa Plateau.
1926	...	...	Chala.
1929-1944	...	...	Plague over most of Africa south of the equator.
1930	...	...	Rungwa, several swarms on Ufipa Plateau.
1936-41	...	...	Few locusts in Rukwa Valley.
1942	...	...	Swarms from North Rukwa.
1943	...	...	Last plague swarms on Ufipa Plateau; few locusts in Rukwa.
1944	...	...	Many locusts in Rukwa, no swarms.
1945	...	...	50-100 swarms left Rukwa.
1946	...	...	Swarms in Rukwa but no emigrants.
1947	...	...	Swarms from Rukwa; Ufipa and Abercorn.
1948-49	...	...	No large populations of locusts.
1950	...	...	Heavy populations, Lusanzi swarm on plateau.
1951-53	...	...	Moderate or low populations.
1954	...	...	Swarms to Kisii (plateau) and Katavi from North Rukwa.
1955	...	...	Heavy breeding in North Rukwa and the collar.

## RELATIONSHIP BETWEEN LAKE LEVELS AND LOCUST BREEDING

When we come to examine the reasons for good and bad breeding years, we find only two causes put forward for bad years; as in 1952-53, there was a period of drought after the first main egg laying, and many eggs dried up and died in the ground. In 1944-45 in Central Rukwa, on the other hand, it was reported by Michelmore that extensive early flooding occurred after egg laying and complete areas of eggs were destroyed by excessive water. A good year for locust breeding seems to be one in which there is sufficiently well-spread rain to keep the soil moist but without flooding it. The question is, however, whether the general level of the lake and the water-table affect the success of breeding.

When we come to collate the information we find a most disappointing series of gaps. The only reports of locusts in the valley before 1913 are for 1893-94 and the species is not known; there was then a plague of *Locusta* in the region. While the lake appears to have been low or dry for ten years from about 1889, this cannot be firmly related to the plague of 1892-1910, for this plague may not have started in Rukwa at all, but, for example, in Mweru wa Ntipa. The locust reports of 1913-1920 can be woven into an uncertain pattern of origin in Rukwa, but nothing is known of lake levels before the dry year of 1920.

There were swarms both inside and outside Rukwa in the ten years after 1920, but the only information on the lake is that it was low in 1929 and higher in 1930. It is clear enough that the main plague of 1929-1944 began elsewhere, in Mweru wa Ntipa.

There is a conclusion to be drawn from the next decade, namely that once the lake level was high, no swarms were produced in the Rukwa. This continued up to 1942, when the lake receded markedly and the first primary swarms appeared.

From then until the present day, there has broadly speaking been increasing dryness, the 1952 floods in the plains being exceptional. During the same period, there has been a progressive increase in the cost of control, which has only just managed to succeed in a number of years, so that it looks as if the success of breeding or the difficulty of control has increased as the plains have extended.

That is not to say that dry years are good breeding years for red locusts, for 1948/49 and 1952/53 were dry and also poor breeding seasons. Nor is it true that when the plains flood the locusts die; a few heavy rainstorms will flood the plains and make control extremely arduous without seeming to interfere with the locust hoppers, once they have hatched, for they do not live on the ground but up in the grass. There is, however, a hypothesis which is worth examining. If the lake level is high, presumably the water table under the grass plains is also high and it then takes little rain to waterlog the ground; such ground is unfavourable to the eggs. If the lake and the water table are low, it is then possible for suitably distributed rains to produce damp soil, comparatively well-drained, of a favourable texture for the eggs. Moreover, in these circumstances the area available for breeding is much larger because of the recession of the lake. If this hypothesis is correct, we are now passing through a most favourable phase for locust outbreaks and cannot expect relief for more than a year or so at a time until we enter a phase of high lake levels like 1937-1942. There are indications, of no more and no less strength, that this hypothesis holds for the other outbreak area of the red locust, Mweru wa Ntipa in Northern Rhodesia (Gunn, 1955).

It seems unlikely that sufficient data can be acquired about the past to permit a rigorous analysis, but the present situation is that paucity of facts permits easy theorizing. It is hoped that more information will be provided by the readers of this article.

It is a pleasure to record my thanks to the Librarian, Royal Geographical Society, London (Mr. G. R. Crone) for invaluable information about early literature concerning Rukwa and also to Mr. G. Hunter for his cheerful help in the library of the King George V Memorial Museum at Dar es Salaam. Information from the Annual Reports of Mr. H. J. Bredo covering his period (1945-52) as Director of the Service proved to be very useful. It is a pleasure to acknowledge with gratitude the assistance of Dr. B. P. Uvarov, C.M.G., F.R.S., the Director of the Anti-Locust Research Centre in London, and the District Commissioner, Sumbawanga (Mr. R. S. Thornton) for access to the Ufipa District records.

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