السودان في رسائل ومدونات

Sudan Notes and Records.

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WHITEHEAD MORRIS EGYPT.

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SUDAN NOTES AND RECORDS

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An Index of the first twenty volumes is printed at the end of Vol. XXI (1938) Part II.

The Editor,
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Khartoum.

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Transliteration of the Arabic Alphabet

adopted by the Editors of *Sudan Notes and Records*

ا	at beginning of word omit, hamza (') elsewhere	ذ	dh (coll. d)	غ	gh
		ر	r	ف	f
		ز	z	ق	q (coll. g)
ب	b	س	s	ك	k
ت	t	ش	sh	ل	l
ث	th (coll. t or s)	ص	ṣ	م	m
ج	j or g	ض	ḍ	ن	n
ح	ḥ	ط	ṭ	ه	h
خ	kh	ظ	ẓ	و	w
د	d	ع	'	ي	y

VOWELS.

fatḥa	a,	lengthened	ā
kasra	i,	„	ī
ḍamma	u,	„	ū

DIPHTHONGS.

ى –ai (as in aisle).

و –au (as in mauser).

The ل of the article always remains *l*.

The silent *t* (ة) is omitted.

NOTES.

1. The system is not applied to well-known names, such as Khartoum, Omdurman, etc.

2. The vowel sounds of *e* in "get" and *o* in "hot" with the corresponding long vowels (*a* in "gate" and *o* in "home"), which occur only in the colloquial, are expressed by e, o, ē, ō.

e.g. beled, Moḥammed, bēt (or beit), ḥōsh.

Ei may be used as alternative to show the long ē.

EDITORIAL NOTES

We have to record with regret the departure of three of those concerned with the affairs of this journal. One of the Joint Editors, Mr. R. A. Hodgkin, is leaving Khartoum to become Principal of the Institute of Education at Bakht el Ruda. Mr. K. D. D. Henderson, a former Editor and recently Chairman of the Committee, leaves to become Governor of Darfur Province; and Mr. G. C. Scott finally retires from the Sudan, a sad loss to the Committee.

* * *

We owe an apology to our readers for the standard of blocks in Volume XXIX Part I, and for the slightly larger size of page than usual. This was due to initial difficulties arising from the transfer of the printing of the journal to a new firm in an effort to accelerate production. With this new Volume we hope to reestablish regular publication of two Parts within the year concerned, after all the dislocation caused by the war. Printing is, however, still liable to difficulties of various kinds.

* * *

In view of the fact that many back numbers are completely or nearly sold out, and are unlikely to be reprinted owing to the heavy cost, it has been decided to charge a slightly higher price, *viz.* L.E. 1.000 for the earlier volumes. Back numbers of many of the earlier volumes are badly needed to make up complete sets for libraries, both public and university, and offers to sell would be gratefully received.

* * *

The list of recent publications on the Sudan is continued in somewhat more systematic form in this number, and it is hoped that it is now tolerably complete for 1947 and 1948, though probably some Government publications have escaped notice. Thanks are due to those in the technical departments who have cooperated in the supply of information. It is interesting to observe that a writer in *African Affairs* of January 1949 suggests that publications such as this journal should carry regional bibliographies at least of matter published in the country concerned. In view of the growth of the publishing field means of ready reference to published material become essential, and not least for the Sudan, since so much of the material in this case appears outside the country. It may be mentioned here that the Middle East office of UNESCO is publishing periodical bibliographies.

* * *

It is good news that the Government has appointed a small committee to consider the question of preserving official archives. Documents and files which may seem of no particular value to contemporaries, acquire great value for the historian and scientific research worker of the future, and the rapid development of the Sudan in the present century may well attract the interest of its students in a later day. Labour is often wasted through ignorance of what has gone before, when facts lie buried in inaccessible official files. Apart from deliberate destruction of papers by careless or ignorant officials, interested only in storage space, conditions in the Sudan are inimical to the preservation of paper and the problem is not only what to preserve but to establish a suitable Records Office, where archives from all departments and provinces can be safeguarded and made available to students.

* * *

The Philosophical Society of the Sudan has continued its series of regular monthly meetings during the winter season: we publish here two of the papers delivered before it and hope to publish more. In addition to the meetings, Field Days have been held for visits to the Gezira Research Farm and elsewhere.

* * *

There has been unusual archaeological activity during the recent winter season. The Commissioner for Archaeology, Mr. P. L. Shinnie, under the joint auspices of the Government and the Egypt Exploration Society has been engaged on the site of the XIXth Dynasty town at Amara West (near Abri). His predecessor, Mr. A. J. Arkell, has returned temporarily to the Sudan to excavate a Neolithic village settlement at Shaheinab, near Wadi Seidna, which he hoped (with justification, as it has turned out) would link up with his earlier excavations of a site in Khartoum. Publication of the latter by Oxford University Press is announced for 1949. Mr. Terence Gray, a member of the Egypt Exploration Society, has carried out for the Archaeological and Museums Board a survey of ancient sites on the right bank of the Nile in the region of the 4th Cataract, between Karima and Abu Hamed. A note appears elsewhere in this number giving further details. Finally Mr. O. H. Myers of the Gordon College has been working on the results of his dig of the previous season at Abka with a view to publication.

* * *

The Sudan has lost a valuable counsellor and firm friend in the recent death of Dr. Charles Morley Wenyon, *emeritus* Director-in-Chief of the Wellcombe Bureau of Scientific Research.

In the early days of this country Dr. Wenyon was one of the brilliant group of investigators whose work made the Wellcombe Tropical Research Laboratories at Khartoum famous all over the world. After a barge had been provided by the Government and equipped by Sir Henry Wellcombe as a floating laboratory, it was Dr. Wenyon—then Protozoologist to the London School of Tropical Medicine—who was in charge on its maiden trip up the White Nile in 1907. Dr. Wenyon's record of his voyage, which lasted nearly a year, is a classic, and he was to rise subsequently to recognition as the foremost authority in medical protozoology throughout the world. Some of the Sudanese staff who accompanied him are still alive and remember him well.

Notes on Principal Contributors.

H. A. MORRICE: Divisional Engineer in the Sudan Irrigation Department. Recently member of the Jonglei Scheme Investigation team.

S. ZENKOVSKY: Has lived in Omdurman for many years as a missionary.

J. W. G. WYLD: Sudan Political Service. Has served in the Zande District for nearly 20 years.

J. W. WRIGHT: Head of the Topographical Section of the Surveys Department.

J. H. K. JEFFERSON: Inspector in the Ministry of Agriculture, recently spent some years in the Sennar area.

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SUDAN NOTES AND RECORDS

Vol. XXX. Part I. 1949

THE DEVELOPMENT OF SUDAN COMMUNICATIONS — Part I.

By H. A. Morrice.

(Part of this article was read as a paper to the Philosophical Society of the Sudan)

PART I.—INTRODUCTION.

1.—The Importance of Good Communications.

"THE first spade of sand of the Desert Railway was turned on the first day of 1897." So wrote Churchill in his classic account of that remarkable enterprise. Railhead reached Abu Hamed on November 1st, Atbara on July 3rd 1898, and Halfaya by the end of 1899. The Atbara bridge, consisting of seven 147-ft steel truss spans, was opened next year. The line from Atbara to Port Sudan with a branch to Suakin was completed in October 1905; four years later the new port was officially opened and since that time it has almost entirely supplanted Suakin. Work on the line from Khartoum to Wad Medani was begun in 1909, and later that year the Blue Nile bridge was opened to connect Halfaya with Khartoum. It comprises seven 218-ft fixed spans and one 110-ft rolling lift span, and has an overall length of 1,835 feet including approach spans. Next year the bridge over the White Nile 4 miles south of Kosti was completed; it consists of nine 146-ft fixed spans with one 245-ft swing span in the centre. As at the Atbara and Blue Nile bridges the piers are steel cylinders filled with concrete. On December 30th 1911 railhead reached El Obeid, 428 miles from Khartoum, 1005 from Wadi Halfa, and 917 from Port Sudan. Karima, which stands on the right bank of the Nile at the head of the navigable Dongola reach, was connected with the Desert Railway some 16 miles north of Abu Hamed by means of a branch line 138 miles long which was opened in 1906.

Thus in a period of exactly 15 years the railway system of this country was constructed substantially as it now is with the exception

of the Kassala-Gedaref loop. Only in the Red Sea hills did the country offer any real difficulties and even here they were not serious; elsewhere construction was easy and consequently cheap. There were no tunnels anywhere and few cuttings of any size (with the outstanding exception of Kamob Sanha in the Red Sea hills); the only important bridges were those already mentioned. Nevertheless the achievement was remarkable; no fewer than 1,660 route miles of railway had been built at an average rate of over 100 miles a year together with three large bridges and a well-equipped modern port. At the same time the Sudan Government undertook the laborious work of clearing the sudd blocks which had formed in the Bahr el Jebel during the last years of the century. Not until 1905 was this task completed, but since then the waterway has never been seriously blocked for any length of time. Thus by the year 1912 the internal communications of the Sudan could fairly be described as excellent, taking into account the standards of the time and the remoteness of the country. Moreover, at this time Darfur was still an independent sultanate and Gondokoro an outpost of Uganda, and so we can fairly say that, relative to the needs and possibilities of the moment, the surface communications of the Sudan were more efficient in 1912 than at any other time before or since.

The outbreak of the First World War in 1914 made it impossible for the Sudan to take immediate advantage of its excellent railway communications. Before this could be done the area of the country was enlarged by the acquisition of Darfur and the adjustment of the Uganda boundary in the south. The less optimistic temperament of the post-war world was reflected in the failure to extend the railway system to Darfur. On the other hand the Gezira Irrigation Scheme was pushed forward vigorously, and on July 15th 1925 the great Sennar Dam was used for the first time to divert irrigation water into the canals. The total area commanded was then about a quarter of a million *feddans*; by 1929 it was over half a million, and the present figure is about 880,000. Without a railway to Port Sudan none of this development would have been possible, and the main source of this country's prosperity would have remained undeveloped.

The development of the Gash Delta as an irrigated area was also undertaken about this time. It was a much smaller undertaking than the Gezira scheme but nevertheless of considerable importance. The soil here is probably the most fertile in the Sudan, and the capital expenditure needed to develop it has been comparatively low; thus the Sudan Government has found the investment highly profitable. Here, as in the Gezira, a railway to Port Sudan was essential, and a

branch from Haiya Junction accordingly reached Kassala on April 21st 1924. This line was built so quickly and cheaply that a description of the organization was included in the standard work on "Military Engineering" issued by the War Office for the guidance of the Royal Engineers. It was prolonged to Gedaref in 1928 and to Sennar in 1929, thus completing a loop-line 500 miles long. The only major work on this loop is the Butana bridge over the Atbara river; it consists of seven 150-ft. spans. With the onset of world-wide depression in the early thirties no further railway construction of any importance was undertaken.

In January 1928 a fine new bridge over the White Nile linked Omdurman with Khartoum by road and tramway, and in the same year work was started on the new terminal port and provincial capital of Juba. River services remained much the same as before, but terminal facilities were greatly improved by the construction of a large inland port at Kosti during the thirties. In the ten years before the outbreak of the Second World War in 1939 the road system of the south was greatly developed, but that of the north remained so primitive that it could scarcely be said to exist. No attempt was made to extend the railways until after the outbreak of war, but three short branches were constructed in the early forties. Of these one connected Wadi Halfa with Faras; a second Malawiya, 17 miles south of Kassala on the Gedaref line, with Tessenei; and a third Rabak with Jebelein.

The foregoing account has shown that the surface communications of the Sudan have developed surprisingly little during the last twenty years; the contrast with the achievements of the first thirty years of this century is remarkable. To a civil engineer, at least, it is also disconcerting, for it can hardly be seriously maintained that the present system has reached a state of perfection which admits of no extension. The fact that it stood up very well to the strain of the recent war should not be allowed to obscure the no less important fact that serious weaknesses then became obvious. Of these the most outstanding were the inadequate links with Egypt, Uganda, and Eritrea, and the lack of any but the most primitive lines of communication with Ethiopia, the Belgian Congo, and French Equatorial Africa. Even internal links were often dangerously weak; thus to supply the airfields of Darfur with petrol became a major undertaking instead of a simple routine operation, and the lack of any reliable road from Khartoum to the far south was a serious inconvenience.

When considering the development of Sudan comunications, we must not forget the important strategic situation of the country. This

derives directly from the fact that the Middle East will almost certainly be in the years to come the largest producer of oil in the world. The Sudan guards one of the main approaches to this region, and that approach would be vital if the Mediterranean route were closed as might quite easily happen. So long as communications between the Sudan and her southern neighbours remain inadequate, she will be unable to fulfil her strategic function of providing access to the Middle East. On the contrary she will herself be liable to attack from that direction, and her friends will be powerless to help her in the absence of adequate lines of communication.

Although we cannot overlook the demands of military strategy there is nevertheless, quite apart from such considerations, an extremely strong case for developing the surface transport system of the Sudan. Stated in its simplest form, this case is that no country can develop soundly without a balanced system of communications. If the system is unbalanced, then development will be lop-sided because it will be limited to those areas with adequate transport facilities. This is exactly what has happened in the Sudan. The north as a whole, and the Gezira in particular, flourish ; but the south and west languish.

During recent years there has been a tendency to lay emphasis on educational and political, rather than on material, developments; on amenities and welfare, rather than on engineering and agriculture. The latter should never be thought of as an end in themselves, but we must not forget that the standard of welfare which a country can support depends in the last resort on its material prosperity. It is because that prosperity itself depends on the proper development of communications that the comparative stagnation of the last twenty years is a cause for alarm. This article should therefore have a considerable topical interest, and the author hopes that it will at least provide a basis for discussing a most important problem.

2.—Characteristics of Rail, Road, and River.

Before discussing the particular circumstances of the Sudan, it will be advisable to consider briefly the characteristics peculiar to each of the three principal forms of surface transport—rail, road, and river. The outstanding advantage of a railway is that it reduces the starting pull required to move a cargo of freight on the level to about one per cent of its gross weight, including that of the empty waggon. It follows inevitably that a locomotive exerting a fixed drawbar pull can haul up a gradient of 1 in 100 only half the load which it could pull on the level.

With a gradient of 1 in 50 the proportion is reduced to one third, and the climb is inconveniently steep ; a slope of 1 in 25 reduces the proportion to one fifth and may be considered the practical limit for a line of any importance. This high sensitivity to adverse gradients is inseparable from the low frictional resistance that is the great advantage of a railway compared with a road. In flat country, such as prevails over wide areas of the Sudan, there is no difficulty in keeping the gradient down without excessive earthwork, On the existing system it reaches 1 in 100 on the climb from Port Sudan to the watershed of the Red Sea hills, but elsewhere the ruling gradient is only 1 in 150. The railway between Massawa and Asmara in an example of the other extreme where the steepest gradient exceeds 1 in 30 and the ordinary locomotives in use can haul only about 60 tons.

To illustrate the difference between rail and road we shall consider the case of a goods engine with four driving axles each carrying 10 tons. Then the effective drawbar pull can be safely estimated at one fifth of the total weight on these axles or 8 tons. Consequently such a locomotive could haul a train weighing 800 tons on the level or one of 480 tons up a gradient of 1 in 150. The nominal capacity of the train can be taken as about two thirds of the gross weight, or 360 tons. Thus we arrive at the conclusion that an ordinary goods train in the Sudan has a carrying capacity equal to that of more than 100 ordinary 3-ton lorries. These figures have been quoted to emphasize that a railway is still by far the most efficient, and often the only practical means of moving large quantities of heavy freight by land. This important fact is well known, but its consequences are often disregarded ; there is a tendency to believe that roads can replace railways for such purposes.

This widespread fallacy arises because most people judge the question from the point of view of passengers in search of convenience and comfort. It is perfectly true that a private car is often more convenient than a train for journeys of moderate length, and even for longer distances, but the fact is irrelevant. In opening up a hitherto undeveloped district the important thing is to move freight cheaply, not to carry passengers in comfort. Moreover, unless the produce of the district consists mainly of some exceptionally valuable material such as gold, it must be transported in large quantities ; for this purpose the railway is far superior to the road. The notion that railways are archaic devices about to be superseded by motor roads and airlines is not supported by the facts. Long-distance passengers will, no doubt, patronize aircraft more and more ; local travellers will prefer cars ; but the railway will remain supreme as by far the cheapest method of

transporting large quantities of goods over considerable distances. It is therefore still a prime necessity for the development of remote districts on any effective scale.

Compared with a road, a railway is expensive to build; therefore it needs a fairly heavy freight traffic in order to realize its potential economies. In new countries it will usually happen that the traffic cannot be developed until the railway has been built. This position too often leads to a circular argument; the authorities are reluctant to build a new line until the traffic has been developed, and fail to appreciate that the traffic can be developed only after the line has been built. There is, of course, always the possibility that no traffic will materialize after all. Against this we may set the certainty that nothing of importance is ever achieved in this world without taking some risk. Recent history is full of railway developments which at first appeared to be financially unsound and ended by paying handsomely, not only in the narrow financial sense but also because they made possible the development of many a prosperous community. Perhaps the most famous case is that of the Canadian Pacific Railway, which was originally built for a political purpose. Another example is the Trans-Siberian, at first an almost purely strategic line but now a vital basis for the development of Siberia. In Africa the original Kenya railway from Mombasa to Kisumu was certainly not built for commercial reasons, but without it the country could never have been developed to anything like the present extent. The Sudan Railways themselves are another good example; to build a line to Port Sudan in 1905 was an act of faith rather than a commercial proposition. That act has since been abundantly justified, but there is room to doubt whether the lesson that it should teach has been learned. Is it fully realized to-day that the vast undeveloped areas of the Sudan can be opened up only by men who believe in the future of this country and are prepared to take risks?

The emphasis laid on railways in the foregoing argument must not be taken to imply that roads are superfluous. On the contrary the Sudan urgently needs a network of modern roads; they cannot, however, economically replace the railway except where traffic is light. Their true function is to provide access to those parts of the country not directly served by the railway, thus acting as feeders and facilitating administration.

We shall now consider the main characteristics of river transport. Its most obvious advantage is that the waterway is provided free of charge, so that capital costs are low despite the expense of terminal

facilities. No less important is the fact that at low speeds frictional resistance is very much less than for any form of land transport. Despite these considerable advantages river services have in many parts of the world been superseded by railways. The commonest reason has been the existence of rapids or shallows that make navigation difficult or impossible. In the early days of development short isolated railways are often built round the rapids, as for instance at Aswan before the construction of the dam. As traffic develops the double transhipment at every interruption of navigation becomes so inconvenient that these isolated sections are joined up with the main system. Even when there are long reaches which are usually navigable (as for instance on the Mississippi, or the Nile and its tributaries south of Khartoum), difficulties and delays usually arise when the water is low. In the past it has seldom appeared worth while to undertake extensive works in order to make a river navigable throughout its course at all times. During the last fifteen years, however, the Tennessee river in the U.S.A. has been developed in this way. The achievements of the T.V.A. were, however, economically possible only because they were directed to more than one purpose. Apart from navigation the main purposes to be considered are irrigation, power generation, and flood control.

Just as recent developments in road transport have tended to obscure the true value of railways, so a century ago the rapid development of railways tended to obscure the true value of inland waterways. During recent years several great projects for providing irrigation water and developing hydro-electric power have been carried out in the western part of the U.S.A. Their success has—or at all events should have—induced among civil engineers a new attitude to the important question of developing a great river. They have shown that the Nile is a much greater potential asset for the Sudan than it appeared to be only a few years ago. To develop this asset will cost a large sum of money. Perhaps we cannot yet afford it, but one thing is certain : we no longer have the shadow of an excuse for failing to investigate the new possibilities that are opening so temptingly before us.

3.—The Financial Aspect.

In the discussions which follow rough estimates will be given of the probable cost of the new railways and roads proposed. For the former, figures are based on an overall cost of L.E. 12,000 per mile. A recent Uganda estimate gives L.E. 15,000 including locomotives and rolling stock if the work were carried out at once ; it seems

reasonable to suppose that present high prices will drop considerably in the not far distant future, and L.E. 12,000 per mile appears to be a fair figure. Present road costs in Uganda are given as L.E. 1,000 for re-aligning and L.E. 750 per mile for surfacing with bitumen. A figure of L.E. 1,500 per mile of new road has therefore been taken as reasonable for the Sudan. It must be clearly understood that all estimates in this article are highly approximate and merely intended to give a rough idea of the expenditure involved.

The total capital cost of providing the whole Sudan with an adequate transport system will be measured in millions of pounds. The annual burden on the budget will depend upon the rate at which the programme is carried out, and can be adjusted within reason. In order to decide whether a particular scheme is worth while, we need to know whether the benefits that will be conferred on the community are such as to justify the effort expended on building and maintaining it. The orthodox financial solution to this problem is to demand that cash receipts in any year shall cover the total annual cost of operating expenses, interest on capital invested, and sinking fund payments for renewals. These last three can usually be forecast fairly accurately, but to estimate cash receipts even approximately is far from easy. It has already been pointed out that there are many examples of railways fomenting enough traffic, in apparently unfavourable circumstances, to satisfy the canons of orthodox finance. Failures have, however, been recorded, as for instance in Tanganyika, though recent developments suggest that the railways of this territory may soon be starting to pay ; one might also mention some lines in South America, but here political troubles have often played a large part.

Another drawback of the orthodox financial criterion is that it appears to afford no agreed method of distributing profits between the various undertakings that combine to form an integrated whole. Thus at one time the Gezira Irrigation Scheme showed on paper a loss while the railway was making large profits carrying the cotton it produced down to the sea at Port Sudan ; by adjusting freight charges it would have been possible to make the railway appear to lose and the irrigation scheme to gain. There seems to be no logical method of settling such problems of allocation. But, even if there were such a method, the financial criterion would still be unsatisfactory, because it assumes that cash receipts are an adequate measure of benefits received. Unfortunately this traditional and conveniently simple theory is not in accordance with the facts. To return to our local example, the benefits of the Gezira Irrigation Scheme unquestionably include many things

that cannot be measured by, and are even quite unrelated to, the profit and loss account. How, for instance, are we to determine the cash value of the greatly increased prosperity that has followed the spread of irrigation on a large scale? What of the indirect stimulus to trade which the scheme has certainly provided? How shall we put a price on the social value of a cooperative scheme that has excited widespread admiration far beyond the frontiers of the Sudan? Those who think that this is an exaggerated picture of the indirect benefits to be derived from the Geizra Irrigation Scheme are invited to consider the following judgment by an expert independent witness:

> "The satisfactory financial position of the Sudan is largely due to the revenues from the Gezira Scheme; before the war it contributed 25% of the gross revenue. The Government has, therefore, been able to finance improvements in other parts of the Sudan. The Gezira Scheme has also improved the food position of the country. Before the scheme began the five million acres of the Gezira produced yearly about 130,000 tons of rain-grown dura. Now, on the one million irrigated acres, about 65,000 tons of dura are obtained off about 100,000 acres."

(Keen, B.A.: *The Agricultural Development of the Middle East*, p. 19. London, H.M.S.O. 1946).

The moral to be drawn should be obvious. We must not permit the future development of the Sudan to be hamstrung by narrow financial theories. Those of us who believe that this country can have a great future must not allow themselves to be overborne by others of little faith. They must insist that the essential basis for a sound development of our resources is an adequate system of communications. They must admit that such a system will cost money, and that the cash returns will often, at least in the early days, fail to satisfy the orderly dreams of the bank clerk. The choice for the future is clear. Either we develop this country with vigour and vision, or we stagnate. This paper is written for those who refuse to believe that progress is impossible merely because the accountants cannot balance their books—for those to whom stagnation is anathema.

PART II.—RAILWAYS.

1. General Remarks.

The railway system of the Sudan as it exists at present has already been sufficiently described. It is an isolated system, nowhere connected with the railways of any of the eight adjacent territories that

have a common frontier with the Sudan. It will be convenient to discuss the development of the railways of the Sudan in terms of connecting links with these surrounding countries. We shall start with Egypt, and work round clockwise through Eritrea, Ethiopia, Uganda, and the Belgian Congo, to French Equatorial Africa. Kenya has been omitted from this list because there can be no question of a rail link crossing her short common frontier with the Sudan west of Lake Rudolf. Libya has also been omitted because her short common frontier with the Sudan is even more remote. To complete our discussion we shall then consider the problem of connecting Juba with the northern Sudan by rail.

It is unfortunate that none of the railways which might be linked with the Sudan system is of the same three-foot-six-inch gauge. In general the gauge question on the continent of Africa is much less involved than in Australia and South America; but neverless there are difficulties, and the Sudan is not well placed. South of the Sahara almost every African railway of any importance has a gauge of either 3 feet 6 inches or one metre. The Union of South Africa, the Rhodesias, Nyasaland, the Portuguese Empire, and part of the Belgian Congo, together form a large area served by lines whose gauge is 3 feet 6 inches; Nigeria and the Sudan have isolated systems of the same gauge. On the other hand the railways of Ethiopia, Kenya, Uganda, Tanganyika, part of the Belgian Congo, and all of the French Empire, have a gauge of one metre. In Eritrea and other parts of the former Italian Empire a freak gauge of 95 cms. has been adopted. North of the Sahara, in Egypt and French North Africa, it has been found convenient for obvious geographical reasons to build main lines to the standard European gauge of 4 feet $8\frac{1}{2}$ inches; light railways of metre gauge are, however, also to be found in these territories.

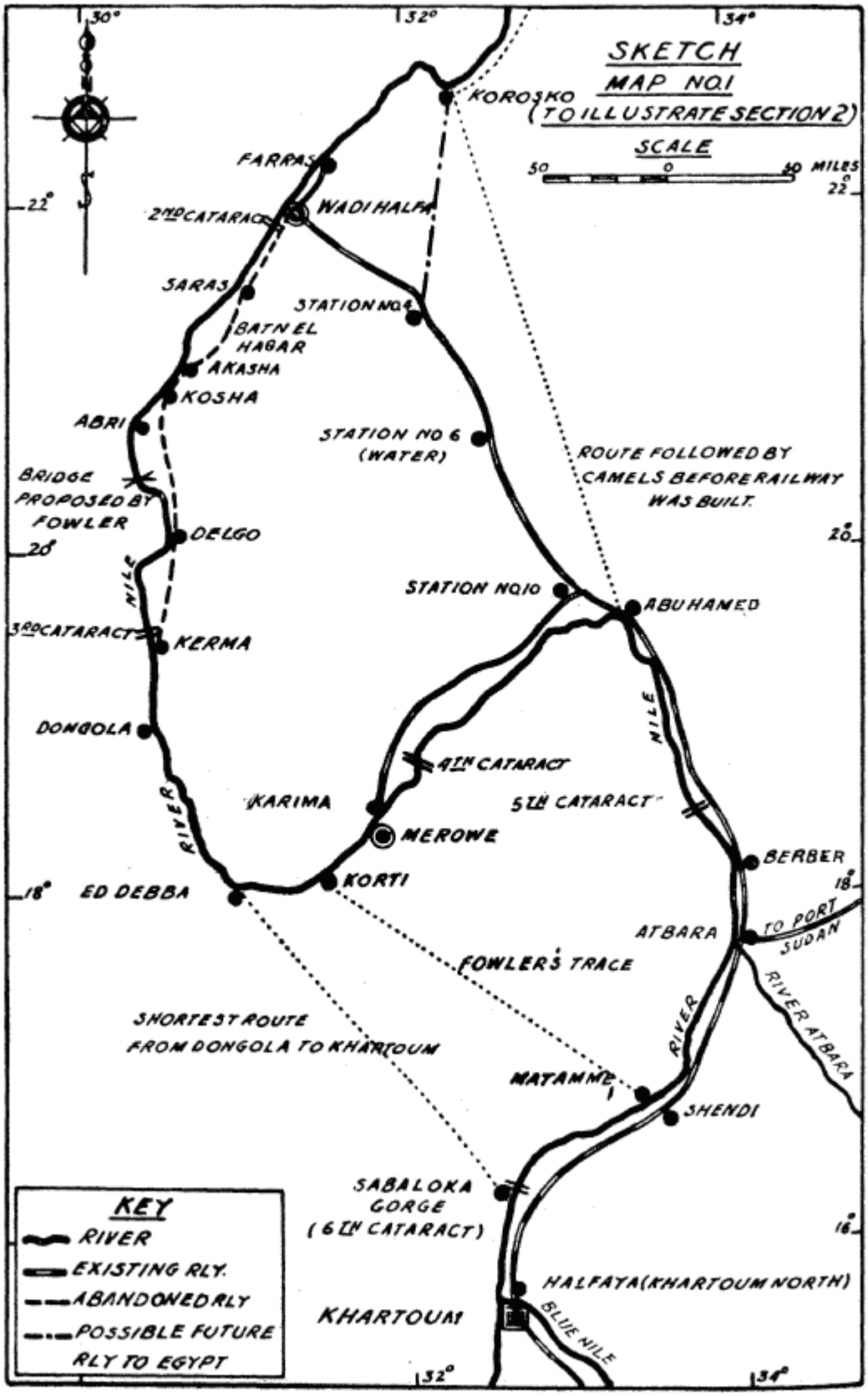
Either 3 feet 6 inches or one metre would be a suitable gauge for Africa south of the Sahara, but the mixture is unfortunate. The difference is under 3 inches and cannot be justified on technical grounds; for the most part it arose naturally from the different units of measurement in use in Britain and on the continent of Europe. Nevertheless both Portuguese territories and part of the Belgian Congo found it convenient to adopt the same gauge as South Africa and the Rhodesias. On the other hand British engineers from India built the Kenya railway to a gauge of one metre, presumably because that gauge is common in India. The Germans chose the same gauge for the railways of Tanganyika, and it would probably pay in the long run to convert them, together with those of Kenya, Uganda, Ethiopia, and part of the Belgian Congo, to the gauge of 3 feet 6 inches. This would practically

solve the African gauge problem south of the Sahara and east of the Niger; thereby much future trouble would, almost certainly, be avoided. The example of Australia should induce the governments of Africa to adopt a standard gauge while it is still comparatively easy to do so.

The cultural and commercial advantages of railway connections with neighbouring countries are too obvious to need special emphasis. However much the Sudan is developed agriculturally and in other ways there will always remain a number of products which can most economically be imported from these countries provided that adequate means of transport exist. Nor must the strategic aspect of communications be forgotten. No sensible person wants another war, but it would nevertheless be most unwise to take no precautions. At present this country has only one reasonably adequate line of communication with the outside world, and that lies through Port Sudan. The route down the Nile to Egypt has a much smaller capacity, and can hardly be considered as truly independent from the strategic point of view. As things are at present there remains only the southern river route to Juba and thence by road to Uganda or the Belgian Congo, but it is quite certain that this by itself would be a most inadequate life-line.

2. A Link with Egypt. (See Map 1).

The question of connecting the Sudan with Egypt by means of an efficient surface route roughly following the valley of the Nile has had a chequered history. In effect it began in 1873 when a project was submitted to the Egyptian Government by a British civil engineer named Fowler who was at that time their consultant. In the absence of a dam at Aswan he proposed to circumvent the First Cataract by means of a funicular railway nearly 2 miles long with a maximum gradient of about 1 in 24. The idea was to lift entire craft fully loaded over a rocky ridge from calm water below the rapids to calm water above. This remarkable project was later abandoned in favour of a narrow gauge railway about 9 miles long from Aswan to Shellal. This line was duly constructed during the seventies and subsequently incorporated in the narrow gauge line from Aswan to Luxor; in the nineteen-twenties it was converted to standard gauge and now forms the most southerly extension of the Egyptian State Railways. From Wadi Halfa southwards, where the Nile again becomes unnavigable, Fowler proposed to build an ordinary railway. For roughly 160 miles this line was to be built east of the Nile, which it was then to cross


SKETCH
MAP NO.1
(TO ILLUSTRATE SECTION 2)
SCALE
50 0 40 MILES
30°
32°
34°
22°
20°
18°
16°
KOROSKO
FARRAS
2ND CATARACT
WADI HALFA
SARAS
STATION NO.4
BATN EL HAGAR
AKASHA
KOSHA
ABRI
STATION NO 6 (WATER)
ROUTE FOLLOWED BY CAMELS BEFORE RAILWAY WAS BUILT.
BRIDGE PROPOSED BY FOWLER
DELGO
NILE
STATION NO.10
ABU HAMED
3RD CATARACT
KERMA
DONGOLA
4TH CATARACT
5TH CATARACT
KARIMA
MEROWE
BERBER
KORTI
ED DEBBA
ATBARA
TO PORT SUDAN
FOWLER'S TRACE
RIVER ATBARA
SHORTEST ROUTE FROM DONGOLA TO KHARTOUM
MATAMMA
SHENDI
SABALOKA GORGE (6TH CATARACT)
HALFAYA (KHARTOUM NORTH)
KHARTOUM
BLUE NILE
KEY
RIVER
EXISTING RLY.
ABANDONED RLY
POSSIBLE FUTURE RLY TO EGYPT

on a bridge some 2,000 feet long with a centre span of about 250 feet ; the site of this work would have been between Delgo and Abri, near where the course of the river changes from west to north. From this point onwards the line was to traverse the province of Dongola hugging the west bank of the Nile as far as Ambikol, near Korti ; it was then to cut straight across the desert for a distance of about 150 miles to the terminus at Metemma, opposite Shendi.

It is interesting to compare Fowler's location with that of the existing railway. The distances from Wadi Halfa are 555 and 470 miles to Metemma and Shendi respectively, and Khartoum would therefore have been about 85 miles further by the former route. The attraction of Metemma is, however, not very clear ; for Fowler could have reached the Nile at Sabaloka by cutting across the desert from Debba. This desert crossing would have been about 20 miles longer, but Sabaloka is only some 540 miles from Halfa by this route and Khartoum would have been little more than 590 compared with 577 by the present line. This difference is not significant, and the western trace has the advantages over the eastern that it serves Dongola province more effectively and has a considerably shorter desert crossing. On the other hand the eastern is better placed for Port Sudan and avoids two bridges over the Main Nile. It is hardly possible to say confidently which route would have been best in the long run. In actual fact a start was made on the western, followed by a switch to the eastern mainly for military reasons, as will shortly be explained.

In 1874 work was begun on the section from Wadi Halfa to the proposed Nile bridge ; the location chosen followed the river closely for 33 miles to Saras and then cut across the stony desert known as the Batn el Hagar to strike the Nile again at Akasha, some 87 miles from Wadi Halfa. By 1878 railhead had reached Saras and the roadbed was finished for a further 30 miles or so. Gordon, who had been appointed Governor-General in 1877, now protested that the financial burden was more than the Sudan could bear, and proposed to limit further railway construction to those reaches between Saras and the Third Cataract which were unnavigable. As a result of his intervention all work was stopped and nothing further was done until 1884, when the unlucky Gordon Relief Expedition carried railhead forward to Akasha. In 1885 the Dervishes occupied Dongola, and the forces of the Egyptian Government gradually retreated to Saras. No further construction work was undertaken until the start of the campaign that culminated in the Battle of Omdurman.

Akasha was reoccupied on March 20th 1896, and it was found that

the railway from Saras had been pulled to pieces. The line was relaid on the old location as quickly as possible and by June 26th trains could once again reach Akasha. From here an extension to Kosha, 108 miles from Wadi Halfa, was at once put in hand ; it was opened on August 4th that same year. From this point the Nile is navigable at high water for 350 miles to the tail of the Fourth Cataract. Relying on this line of communication, the Anglo-Egyptian army reoccupied Dongola in September and advanced to Merowe. At low water, however, the Third Cataract becomes impassable, and consequently it became urgently necessary to extend the railway to Kerma. Work was started in October 1896, but construction was hampered by the necessity for using the unfinished extension as a line of supply for the army ; hence railhead did not reach Kerma until the following May. The total distance from Wadi Halfa was 203 miles.

Early in December 1896 it was decided that the army should advance towards Omdurman, and it was then that, in the words of Churchill, " the momentous question of the route to be followed arose." The obvious solution was to connect the Dongola reach, which is navigable at all seasons, with the southern end of the Sabaloka gorge, whence steamers can reach Omdurman at all times of the year. This line of argument leads to the already mentioned 170-mile desert crossing from Debba to Sabaloka. It appears from Churchill's account, however, that only the geographically inferior Korti-Metemma route was considered. The main reason for preferring the desert railway by Abu Hamed appears to have been the purely military need for a line of approach that could not easily be interfered with by the Dervish army. This choice was, nevertheless, based to a certain extent on two misapprehensions. It was, in the first place, supposed that between Merowe and Abu Hamed " the broken ground of both banks made a railway nearly an impossibility." So wrote Churchill, but in fact the Karima branch traverses quite easy country and would have been nearly 80 miles shorter than the desert railway. The second misconception was more serious ; in the words of Churchill " it was believed that the Nile was always navigable above Abu Hamed." When one considers that the Egyptians had formerly controlled for many years the reach of the Nile between Berber and Abu Hamed, it is hard to understand how they could have failed to notice the Fifth Cataract. The result of the decision to adopt the eastern route was that the railway had to be hastily extended a further 150 miles to Atbara, between which point and the Sabaloka gorge the Nile is almost always navigable.

At the end of 1896 Wadi Halfa was the terminus of a railway that was being rapidly extended to Kerma and an important supply base for the army in the field. In these circumstances it was inevitable that it should be chosen as the point of departure for the new desert railway. Nevertheless, if one considers this line as a link with Egypt, the natural northern terminal is Korosko, and it was doubtless for this reason that work here on a very small scale was actually started towards the end of 1895. Situated between Halfa and Aswan and about 110 river miles from either, this village had, before the construction of any railway, been the point of departure for camel convoys to Abu Hamed. Because it lies on a sharp bend of the Nile, Korosko is only some 10 miles further from Abu Hamed than Wadi Halfa is. Had the eastern route been decided on from the first, Korosko rather than Wadi Halfa would almost certainly have been the starting point. The present location can thus fairly be described as the result of a historical accident. Its effect has been to make more difficult a direct connection between the railway systems of Egypt and the Sudan, and also to introduce navigation difficulties at low water near Halfa which a railway terminus at Korosko would have avoided. As things now are the best location for a connection would probably diverge from the desert railway at a point where it turns north-west not far from No. 4 station and about 70 miles from Halfa. It would strike the Nile near Korosko some 85 miles from the bifurcation and follow the general course of the river to Aswan. The bank is rocky, but there would be no need to hug it closely and a reasonable location could probably be found a short distance inland. The total length of the connecting link would be about 200 miles, and the cost something in the region of two and a half million pounds.

The advantages of a rail link with Egypt are sufficiently evident, but it may well be doubted whether they would justify such an expenditure. As far as passenger traffic alone is concerned they certainly would not, however tedious and exasperating the present arrangements may at times be. Moreover, in future first class passengers will often prefer to fly ; most other travellers will probably be prepared to accept delays philosophically, and anyhow a more practical alternative for them would be a road along which lorries and buses could operate. Would freight traffic justify the link ? For most classes of goods, to save time is of little importance, but to avoid transhipment costs is highly desirable. At present the only essential transhipment is at Wadi Halfa, from which point barges can reach Alexandria. No doubt goods are in practice quite often handled again at Shellal, but this is

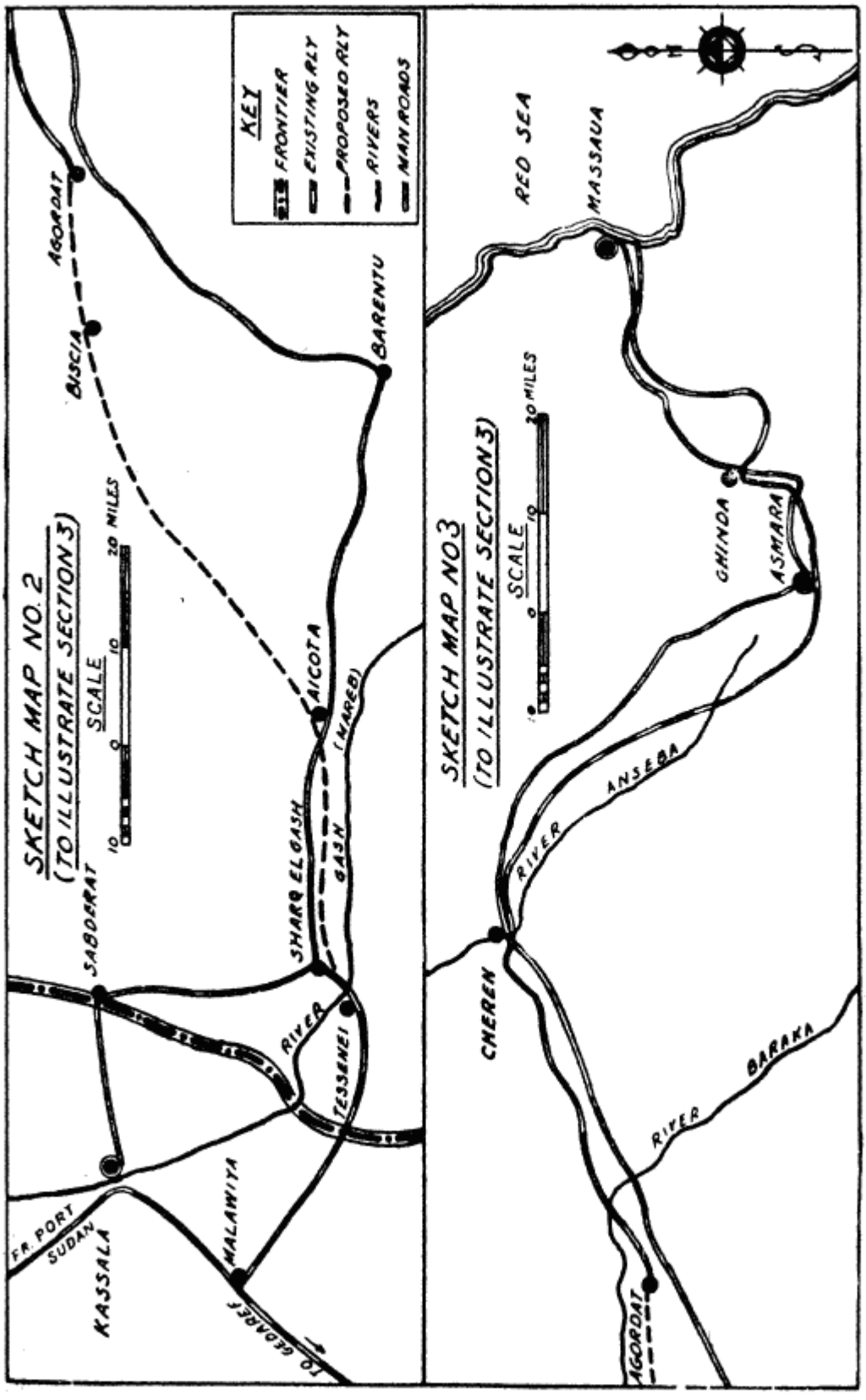
not necessary and it ought to be much cheaper to continue by barge rather than by rail. Owing to the gauge break a rail link would still leave us with one transhipment, presumably at Aswan. The only way to avoid this would be by using specially designed wagons whose wheels could be adjusted to either gauge by sliding them along their axles. Such as device is technically possible even for such a large gauge difference as 14½ inches, but there are several obvious inconveniences. The conclusion appears to be that freight traffic would be unlikely to justify the cost of building a rail link between the desert railway and Aswan.

In this particular case it seems improbable that any considerable secondary benefits would follow the construction of a railway. If it is ever built, the reasons are unlikely to be purely or even mainly commercial. There is, however, one other possibility that is perhaps worth mentioning. It has been suggested that the Aswan Dam might be heightened to such an extent that the town of Wadi Halfa would be submerged when the reservoir was full. Should this proposal ever be carried into effect, it would probably be more satisfactory to abandon Halfa and build a new town at Korosko above flood level and served by a new railway from Station No. 4 as suggested above. During the recent war a branch about 15 miles long was built following the river to Faras on the frontier. The sole object of this line was to avoid navigation difficulties near Halfa at low water ; for reasons just explained it cannot be considered as the start of a connection with Egypt.

The old Kerma railway was closed at the end of 1904, and most of the track was removed to be relaid on the Karima branch. With gradients as steep as 1 in 60 and very sharp curves it had become uneconomical to operate, though the situation would have been quite different had it formed part of the main line of communication between Halfa and Khartoum. As already explained, this very nearly happened, and the whole story of the Kerma railway provides an interesting example of interaction between military, political, and geographical considerations.

3. A Link with Eritrea. (See Maps 2 and 3).

In 1888 the Italians began to build a railway inland from the port of Massawa, on the Red Sea coast. By 1904 it reached no further than Ghinda, about 45 miles inland and some 3,000 feet above sea level. The country was difficult and the line was therefore built with a ruling gradient of 3% and curves with a radius as low as


KEY
FRONTIER
EXISTING RLY
PROPOSED RLY
RIVERS
MAIN ROADS
SKETCH MAP NO. 2
(TO ILLUSTRATE SECTION 3)
SCALE
0 10 20 MILES
AGORDAT
BISCIA
BARENTU
AICOTA
SABDERAT
SHARQ EL GASH
GASH (MAREB)
RIVER
TESSENEI
KASSALA
MALAWIYA
FR. PORT SUDAN
TO GEDAREF
RED SEA
MASSAUA
SKETCH MAP NO3
(TO ILLUSTRATE SECTION 3)
SCALE
0 10 20 MILES
GHINDA
ASMARA
ANSEBA
RIVER
CHEREN
BARAKA
RIVER
AGORDAT

100 metres; on the climb from Port Sudan the corresponding figures are 1%, and about 350 metres. The extension from Ghinda to Asmara was built between 1904 and 1911, and is a remarkable feat of engineering. For about 28 miles the line climbs on a practically continuous grade of 3½%, threading its way through over 20 tunnels to the summit level of just under 8,000 feet on the outskirts of Asmara. Curves on this section are numerous and some are only 70 metres in radius. The distance from Massawa to Asmara is about 75 miles by rail, though under 45 as the crow flies, and there are 29 tunnels on the way. Westwards from Asmara the railway was prolonged, first for some 65 miles to Keren at an altitude of about 4,500 feet, and then to Agordat on the upper Baraka approximately 55 miles further and only 2,000 feet above sea level. The ruling gradient west of Asmara is 2½% and there are nine tunnels.

In 1924 the Italians started work on their irrigation project at Tessenei on the Gash river; four years later it was formally opened by the Prince of Piedmont. The original intention was to extend the railway from Agordat to Tessenei, a distance of about 100 miles, and a considerable amount of work was actually carried out. This included laying the rails as far as Biscia, 23 miles west of Agordat; a certain amount of earthwork in the next 30 miles or so; and the foundations for a bridge over the Gash at Tessenei. Railhead appears to have reached Agordat about 1917, and from there onwards the line would have been comparatively easy to build. When one considers the great difficulties which had been conquered in carrying the railway over the mountains from Massawa and down into the plain, it is not easy to understand why the project should have been abandoned with the goal in sight. Attention seems to have been diverted to the new road from Asmara through Agordat and the outskirts of Tessenei to a point on the frontier about 20 miles from Kassala.

Early in 1941 allied forces started to invade Eritrea, and the question of connecting the Sudanese with the Eritrean railways at once became urgent. Malawiya, a station 17 miles south-west of Kassala, was chosen as a point of departure, and a branch line about 35 miles long was rapidly pushed forward to Tessenei. After some discussion it was decided to use the old Italian foundations for a bridge to carry the railway across the river Gash. The decision may seem natural, but it disregarded the existence of a much better bridge site a few hundred yards downstream where the river entered a narrow gorge below the weir that the Italians had built. The approaches to this site were somewhat awkward, but excellent rock foundations were available and

had been used by the Italians for a road bridge which they had demolished before retiring. Having made this doubtful decision, the military engineers then proceeded to erect a strange structure. With ample supplies of excellent sand and stone right on the site they preferred steel piers protected by concrete cutwaters. To make matters worse these supports had to be inordinately wide because the steel spans used would otherwise have been too short ; all warnings about the danger of obstructing so torrential a stream as the Gash were disregarded. The conditions on the site undoubtedly called for slender masonry piers carrying reinforced concrete spans, and the military engineers made a serious error in deciding otherwise. They could not even claim that the work was urgent, for they had at least three clear months before the Gash came down in flood. Within two years their unfortunate structure was pronounced unsafe ; by 1945 it became necessary to remove two spans, and in 1946 the free pier collapsed completely.

Meanwhile the railway was carried across the Gash on a low-level embankment and prolonged for a mile or so to a large base depot for military stores that was subsequently known as Sharq el Gash. After the Battle of Keren and the fall of Asmara early in April 1941 there was little strategic need for this link, and consequently no further work was undertaken. The position now is, therefore, that a gap of 70 miles remains to be filled and a properly designed bridge over the Gash to be erected. Part of the earthwork has already been done, and the total cost of completing it should not exceed three-quarters of a million pounds. The advantages to be derived from such a link are considerable. Asmara has a large European population and enjoys one of the best climates in Africa. Admittedly the European population of the city has been greatly inflated as a result of Mussolini's Abyssinian war and may therefore decrease as conditions become more normal. Nevertheless Asmara will certainly continue to enjoy a combination of good climate and a supply of industrious and comparatively skilled labour that will together be unique in central east Africa. These important advantages can best be developed by providing good communications with the Sudan where lies the most promising natural market for its products.

The gauge of the Eritrean railway is only about 4½ inches less than that of the Sudan system. Conversion would therefore not be difficult, but unfortunately this alone would not enable Sudan locomotives and rolling stock to operate in Eritrea. The reason is that the Eritrean loading gauge is considerably smaller than the Sudanese. In most parts of Africa it would be quite a simple matter to convert

the loading gauge; but in this case the existence of numerous tunnels, which would have to be enlarged, raises serious difficulties. The best solution to the problem would probably be by stages. At first all goods would be transhipped at Agordat, the last important station on the plain; then the track gauge would be converted as far as Asmara to enable specially built wagons to work through from the Sudan. For the third stage the tunnels between Agordat and Keren would be enlarged to the Sudan loading gauge, and goods for Asmara not carried in special wagons would then be transhipped at Keren instead of Agordat. Finally the tunnels between Keren and Asmara would be enlarged, thus making Asmara accessible for all Sudan locomotives and rolling stock.

Conditions between Asmara and Massawa differ markedly from those which prevail to the west, To convert the track gauge would be no more difficult here than elsewhere, but the very large number of tunnels makes any conversion of loading gauge a formidable task. Moreover, curvature is so severe that even with enlarged tunnels it is doubtful whether ordinary Sudan rolling stock could be worked over this section of the line and quite certain that severe speed restrictions would be inevitable. From the Sudanese point of view the only real point in converting the Asmara-Massawa section would be to provide direct access to the port of Massawa. This conversion could therefore be justified as far as the Sudan is concerned, only if Massawa were a better outlet than Port Sudan. In fact, however, the latter is a better harbour with a better climate, and is separated from its hinterland by a mountain barrier that is much less formidable than the hills of Eritrea. As for distance, the station of Malawiya is 360 miles from Port Sudan and would be about 330 from Massawa by rail; such a difference is not significant. The conclusion is obvious. The line to Massawa must be regarded solely as a feeder connecting that port with Asmara, and not as an extension of the railway system of the Sudan. It might perhaps be convenient to convert the track gauge, but special locomotives and rolling stock would always be needed. Such a conversion would, however, cost little, and would enable special stock to be worked through on occasion from Massawa to the Sudan.

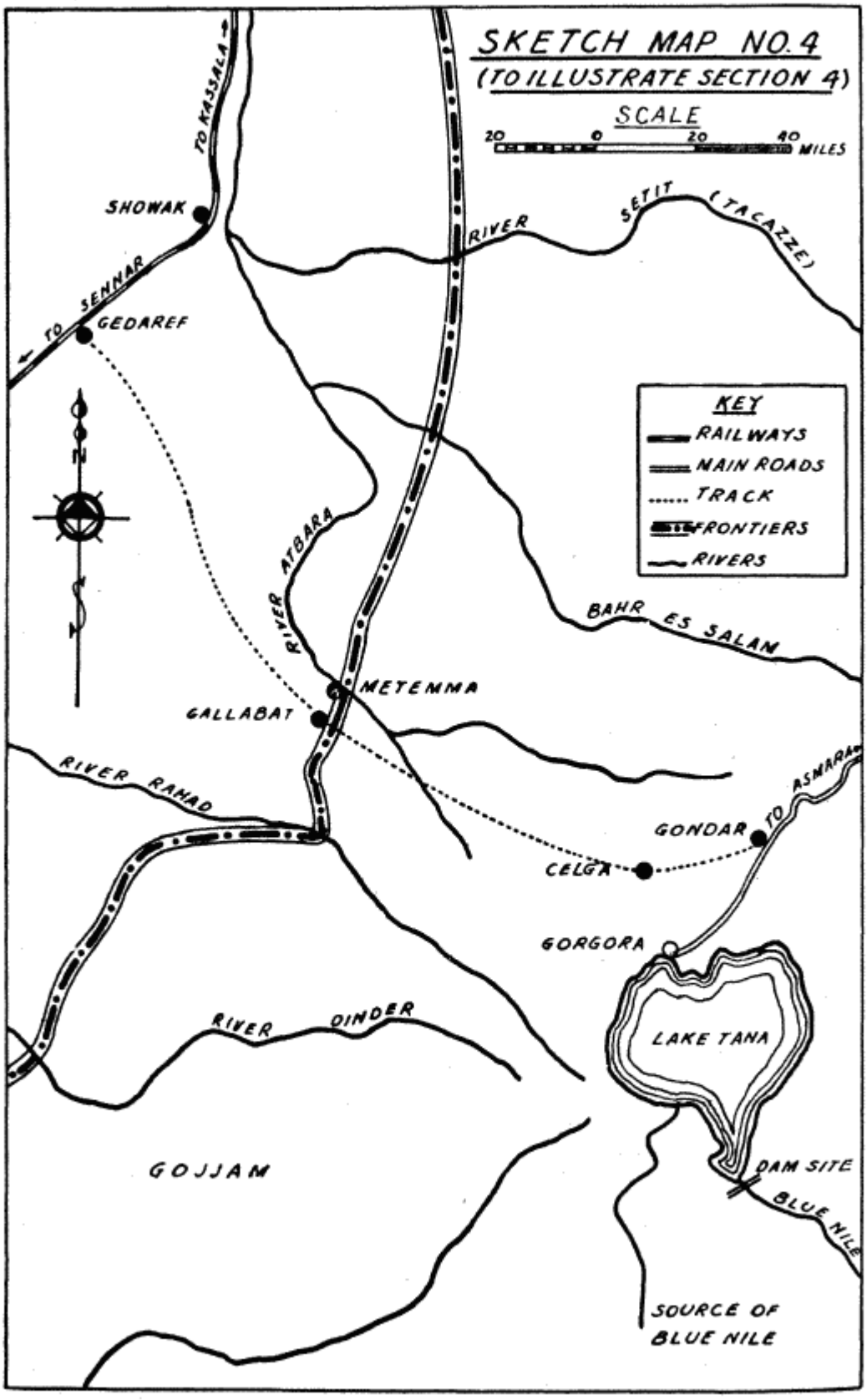
The Sudan is a flat country, and we are not accustomed to mountain railways. The result is a tendency to over-estimate the difficulties of operating them and to undervalue their advantages. When gradients are steep train loads must naturally be reduced, but there is nothing very extraordinary in operating a gradient of $2\frac{1}{2}\%$ (1 in 40) such as prevails between Agordat and Asmara. Many mountain

railways in other parts of the world are at least as steep and are operated without undue difficulty. The 3½% grade on the Massawa section is, however, a different matter. There are very few places in the world where any appreciable freight traffic is worked up a long incline as steep as this, and it must always be expensive to operate such a line. Electrification would probably improve matters from the operational point of view, but the cost would be heavy. The Italians considered it worth while to supplement the Asmara-Massawa railway with an overhead cableway 45 miles long, and claimed that goods could be transported in this way just as cheaply as by rail. Fortunately, for reasons already explained, the Sudan is not directly concerned with the awkward problem of carrying bulk freight cheaply and efficiently between Asmara and Massawa.

4. A Link with Ethiopia. (See Map 4).

The north-western part of Ethiopia consists essentially of a high plateau across which the principal rivers have scoured deep and narrow gorges. As a result the best lines of communication follow watersheds, and river valleys are obstacles rather than thoroughfares in marked contrast to most mountainous countries. The capital city of Addis Ababa stands at an altitude of some 8,000 feet above sea level, at the head of the chain of lakes that ends at Lake Rudolf, and at the southern end of the great road built by the Italians that leads to Eritrea along the watershed between the Blue Nile and the Danakil depression. The natural importance of the site is enhanced still further by the fact that it is the inland terminus of the Franco-Ethiopian railway, the only one in the country. The French started work at the port of Jibuti in 1896, but, mainly owing to financial difficulties, railhead did not reach Addis Ababa until 1917. The line is just under 500 miles long and has a ruling gradient of 2½%. In order to avoid gauge difficulties in future there is much to be said for converting this line to the gauge of 3 feet 6 inches and adopting the same gauge for any others that may be built in Ethiopia.

Considerable areas of Ethiopia are high enough to enjoy an excellent climate. A conspicuous example is the plateau of Gojjam which lies between the big loop of the Blue Nile and the plains of the Sudan. To the north is Lake Tana, which has great potential importance for irrigation in Egypt and the Sudan. For this purpose a dam would be built at the southern end of the lake where the Blue Nile starts on its thousand-mile course to Khartoum; water could then be stored


SKETCH MAP NO. 4
(TO ILLUSTRATE SECTION 4)
SCALE
20 0 20 40 MILES
TO KASSALA
SHOWAK
TO SENNAR
GEDAREF
SETIT (TACAZZE) RIVER
KEY
RAILWAYS
MAIN ROADS
TRACK
FRONTIERS
RIVERS
N
RIVER ATBARA
BAHR ES SALAM
METEMMA
GALLABAT
RIVER RAHAD
GONDAR
TO ASMARA
CELGA
GORGORA
LAKE TANA
RIVER DINDER
GOJJAM
DAM SITE
BLUE NILE
SOURCE OF BLUE NILE

here during the rains and released during the dry season. The only good line of communication that connects Lake Tana with the outer world is the motor road built by the Italians from Asmara to Gondar. This road crosses first the valley of the upper Gash, here known as the Mareb, and then the great gorge of the Setit, here known as the Tacazzé ; it then follows the watershed of the Atbara to reach the northern shore of the lake 35 miles beyond Gondar and 380 miles from Asmara. Though a fine piece of engineering this road traverses such rugged country that it is both tortuous and hilly ; it therefore cannot be considered an adequate line of communication either for the purpose of developing the Gojjam plateau or for building a dam.

We are thus led to consider the possibility of connecting Lake Tana by rail with the Kassala-Gedaref loop; the obvious starting point for such a branch would be Gedaref itself which lies about 170 air miles from the north-west corner of the lake. For the first 100 miles or so to the frontier town of Gallabat the country is fairly easy, but from here onwards the natural route up the headwaters of the river Atbara becomes increasingly difficult. During the next 80 miles or so it is necessary to climb over 4,000 feet to an altitude of some 6,700 feet, after which there is a comparatively gentle descent to the lake shore 6,000 feet above sea level. The barrier formed by this escarpment is by no means insuperable, but to build a railway up it with a reasonable ruling gradient would not be cheap. Once on the plateau the line could easily be extended to the dam site, though it might be found more economical as far as the dam was concerned to construct a small port and operate a service of steamers and barges. A very rough estimate for the cost of a railway from Gedaref to Lake Tana would be three million pounds ; this figure includes an allowance for the difficulty of climbing the escarpment.

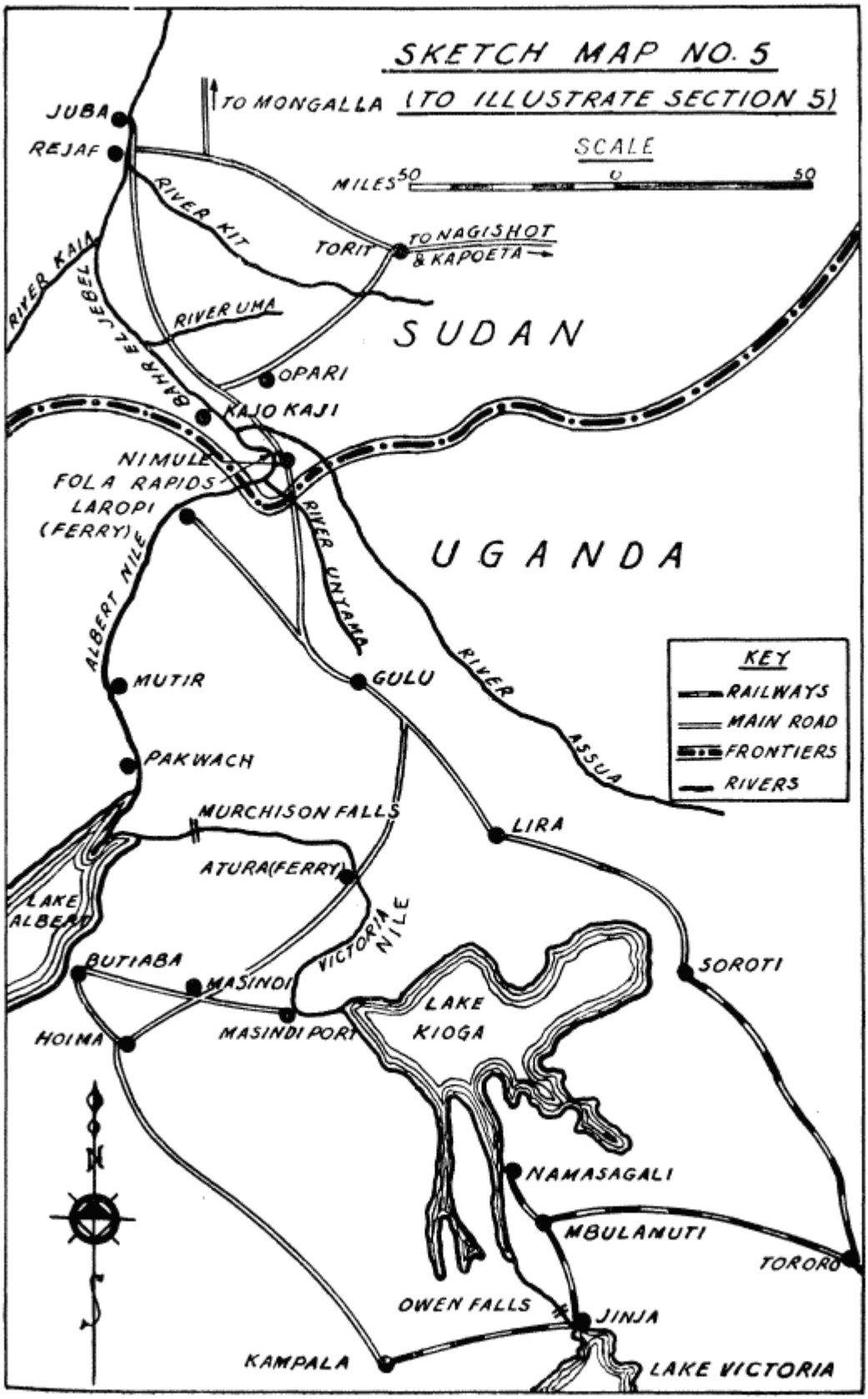
In considering other possible connections with Ethiopia we shall first look at the matter from the Sudan point of view. One would normally expect the valley of a large river like the Blue Nile to provide a fairly easy route to its upper catchment, but unfortunately it flows for the greater part of its course in Ethiopia through a formidable canyon and is thus useless as an access route. The only other promising line is up the Baro valley from Gambela, which is the head of navigation during the flood season and lies about 450 miles west of Addis Ababa. The intervening country is far from easy, and it seems unlikely that this line of access will be developed. To the south of the Baro the frontier plains of the Sudan are remote, sparsely populated, and liable to be flooded ; hence they are not suitable as a starting point for a

route across the frontier. Looking at the matter now from the Ethiopian point of view, we naturally start from Addis Ababa whose strategic situation has already been described. The easiest route from here for a railway in the general direction of the Sudan would be along the chain of lakes towards the remote south-eastern corner of the Sudan, but such a line would be quite useless as a link between the two countries. We have already dealt with the route due west to Gambela ; there remains only that across Gojjam to Lake Tana. The distance from Addis Ababa to the point where the Gedaref branch would strike the lake is about 350 miles, and the country is probably not particularly difficult with the single but outstanding exception of the Blue Nile gorge. Despite this formidable obstacle there can be little doubt that, even from the Ethiopian viewpoint, the most natural route into the Sudan is by the plateau of Gojjam and Lake Tana.

The geographical obstacles to easy communications between Ethiopia and the Sudan have always played an important part in the history of the relations between these two countries, and they will continue to do so. To the east rises the great Ethiopian tableland furrowed with tremendous gorges ; to the west the vast Sudanese plains are almost always difficult to cross either because there is little or no water to drink or because they are flooded. The political boundary does not always follow closely the natural division between highlands and lowlands formed by the edge of the escarpment, but nevertheless there can be few other frontiers in Africa across which communications are so difficult to maintain.

5. A Link with Uganda. (See Map 5).

We shall here consider the question of connecting Juba with the Kenya-Uganda railway system. The possibility of building a line from Juba northwards to provide a direct link with the main Sudan system will be discussed in Section 8 below. The first railway in Uganda was opened in 1912 ; it connected Jinja on Lake Victoria with Namasagali at the head of the first navigable reach of the Nile, and was 61 miles long. Ten years before, the Kenya railway had reached Kisumu, a port on Lake Victoria 587 miles from Mombasa. Direct connection between these two railways was not established until early in 1928 when the present main line reached Mbulamuti, a station 18 miles from Namasagali. Shortly afterwards railhead reached Kampala, 879 miles from Mombasa and the commercial capital of Uganda. The first station in Uganda is Tororo, 686 miles from Mombasa and junction for a branch


SKETCH MAP NO. 5
(TO ILLUSTRATE SECTION 5)
TO MONGALLA
SCALE
MILES 50 0 50
JUBA
REJAF
RIVER KIT
TORIT
TO NAGISHOT & KAPOETA
RIVER KAJA
BAHR EL JEBEL
RIVER UMA
SUDAN
OPARI
KAJO KAJI
NIMULE
FOLA RAPIDS
LAROPI (FERRY)
RIVER UNYAMA
UGANDA
ALBERT NILE
MUTIR
GULU
RIVER ASSUA
KEY
RAILWAYS
MAIN ROAD
FRONTIERS
RIVERS
PAKWACH
MURCHISON FALLS
LIRA
ATURA (FERRY)
LAKE ALBERT
VICTORIA NILE
BUTIABA
MASINDI
SOROTI
LAKE KIOGA
HOIMA
MASINDI PORT
N
NAMASAGALI
MBULAMUTI
TORORO
OWEN FALLS
JINJA
KAMPALA
LAKE VICTORIA

line 101 miles long that runs north-westwards to Soroti and was opened in 1930. The distance from Tororo to Mbulamuti is 97 miles; hence Namasagali is 801 miles, and Soroti 787, from the seaport of Mombasa by rail.

At present the only regular through transport service between Juba and the Uganda railway system is both tedious and complicated. The first stage is by road to Nimule, about 120 miles from Juba; the second by river steamer for another 120 miles or so to Pakwach; the third by lake steamer to Butiaba on Lake Albert, 170 miles from Nimule; the fourth by road for 75 miles to Masindi Port; and the last by steamer once more across Lake Kioga for just over 100 miles to Namasagali. Thus in a total distance of about 580 miles goods must be handled no fewer than four times excluding transhipments at either end. Even passengers take four days to do the trip, and the route can fairly be described as quite fantastically inconvenient. As an economic means of transporting freight in any large amounts it is obviously unsuitable.

In a recently published official Development Plan for Uganda (by E. B. Worthington) two extensions to the existing railway system are discussed. Of these the first is westwards from Kampala and of no direct interest to the Sudan; the second is north-westwards from Soroti to Nimule and therefore affects the Sudan intimately. Worthington estimates the length of this extension at 170 miles, and the cost at more than two million pounds. While admitting that "it would certainly allow much development of the country" traversed, he considers that a "capital investment of this amount is probably not justified" for Uganda alone. After mentioning the possibility of connections with Juba and the Belgian Congo, he points out that a railway to Nimule would greatly reduce the cost of any dam that might be built there. Worthington concludes that the project "depends mainly on decisions which are beyond the scope of Uganda"; he adds that the extension to Nimule, if built, "should, if possible, be aligned in such a way as to serve Uganda as well." Since Worthington's figure of 170 miles is an air-line distance, this last very reasonable condition would probably result in an extension 200 miles long serving both Lira and Gulu directly.

It should now be clear that the natural access route from Juba to Uganda and Kenya is through Nimule and Soroti. This is true not only for a future railway but also as communications now are; for Soroti is slightly nearer to Nairobi and Mombasa than Namasagali is, and only 328 miles from Juba over a good motor road which can easily

be traversed in two days. Compared with the Namasagali route, traffic by Soroti takes less than half the time and avoids four transhipments at the cost of about 130 additional road miles. It was used by military transport during the recent war, but otherwise, for reasons by no means evident, the roundabout Lake Albert route has been preferred. A third possible route is by road for just on 230 miles to Atura, and then by water for 160 miles to Namasagali. Atura lies on the Victoria Nile at the head of a chain of rapids some 50 miles long which culminates in the great Murchison Falls; the Victoria Nile enters Lake Albert about 20 miles west of these falls and 30 miles north of Butiaba. Before the railway was opened to Soroti the Atura route offered certain advantages but since then it has lost them.

From Soroti to Nimule the proposed railway would follow first the watershed between Lake Kioga and the upper Assua and then the Unyama valley; such a location is geographically desirable and construction should be quite easy. We have now to consider the best location for the 120-mile stretch between Nimule on the east bank of the Bahr el Jebel and Juba on the west. For several reasons local geography favours a location mainly on the west bank. In the first place by far the best bridge site is at the Fola Rapids some 5 miles north of Nimule, where the river races through a rocky channel which is in places less than 20 metres wide. A second reason is that the tributaries on the west are both fewer and smaller than those on the east because the eastern edge of the highlands forms a watershed near the Bahr el Jebel for a large part of the way. In fact, the Kaia is the only important west-bank tributary, whereas on the east we have the Assua, the Uma, and the Kit. A third advantage of the west-bank location is that it would not duplicate the existing road from Nimule to Juba; on the other hand it would be quite easy to tap the fertile Kuku country round Kajo-Kaji by means of a short feeder road up the escarpment. For all these reasons it seems probable that the best location for a railway from Nimule to Juba will be found on the west bank from the Fola Rapids northwards. The total cost of the railway from Soroti to Juba should not exceed three and a half million pounds, of which perhaps two million would be debitable against the Sudan.

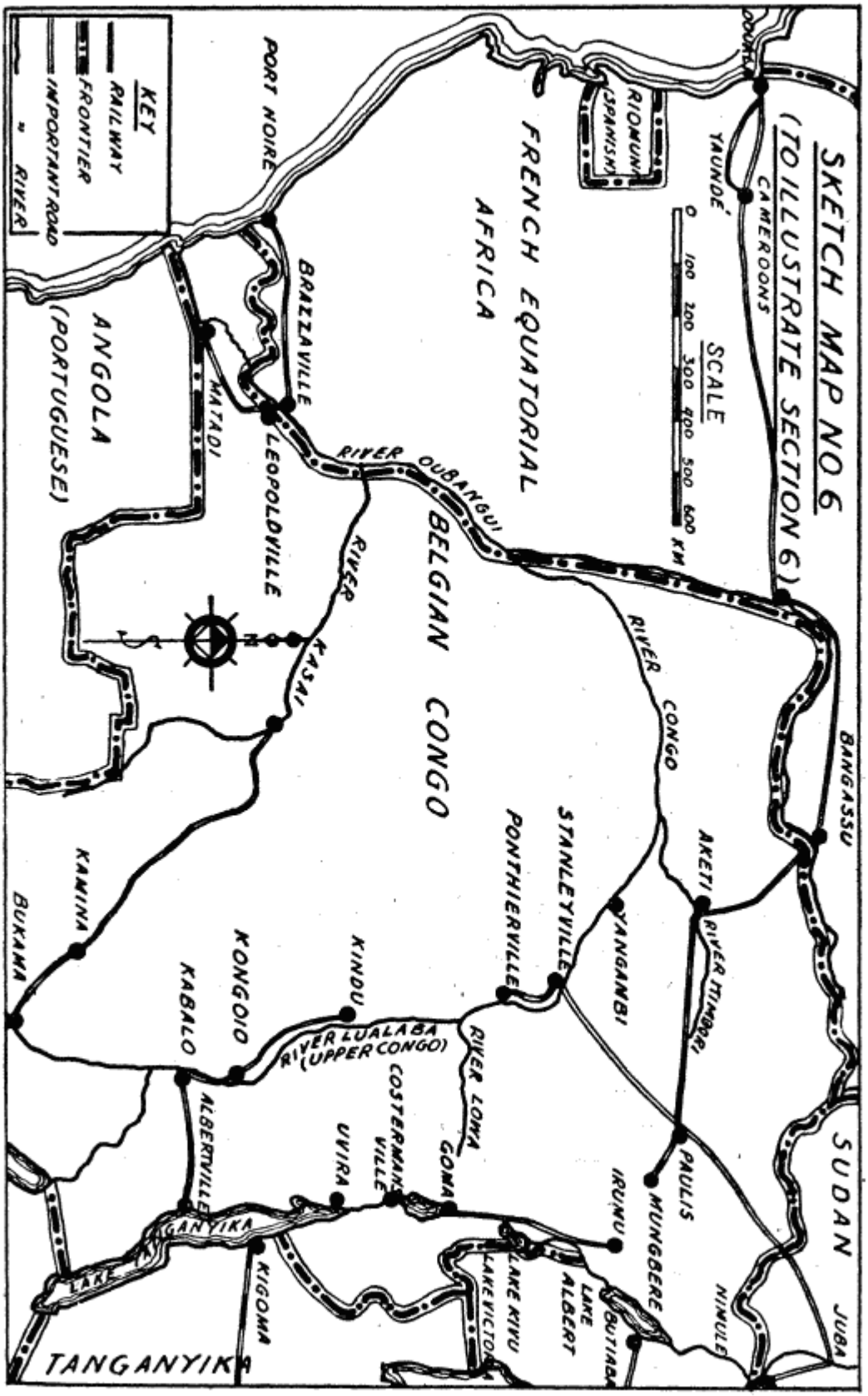
This is a convenient place in which to consider what is the best outlet from Juba and the southern Sudan to the sea. The three possible outlets are: Mombasa, Port Sudan, and Matadi, the ocean port at the mouth of the Congo. Details of these three routes are as follows:—

Route	Distances in Miles			
	Road	*Rail*	*River*	*Total*
Juba to Soroti	328			
Soroti to Mombasa		787		
Juba to Mombasa ..				1115
Juba to Khartoum			1100	
Khartoum to Port Sudan ..		490		
Juba to Port Sudan ..				1590
Juba to Stanleyville	800			
Stanleyville to Leopoldville ..			1100	
Leopolodville to Matadi ..		230		
Juba to Matadi				2130

Clearly the choice lies between Mombasa and Port Sudan. Mombasa is considerably nearer, and a railway from Juba to Soroti would avoid all transhipments. On the other hand the route to Port Sudan is largely by water and might therefore be cheaper even though one transhipment is unavoidable. The distance from Juba to the Mediterranean Sea is 3,000 miles by river ; for produce to be sold in Europe this would be the best outlet of all, if only the Nile were navigable all the way. The possibility of making the Nile navigable throughout is discussed in a second article.

6. A Link with the Belgian Congo. (See Map 6).

The Belgian Congo is divided from French territory by the Oubangi, an important tributary of the great Congo river ; and from British and Sudanese territories by a frontier that follows fairly closely the Congo River watershed. Thus the whole country, which is nearly as large as the Sudan, lies within the basin of the Congo, and the numerous navigable waterways provided by that river and its many tributaries form the basis of its transport system. In the south river services are supplemented by a railway whose primary object is to serve the important Katanga copper mines. This line crosses the upper Congo at Bukama, 2600 miles from Cape Town by rail and 600 from the northern terminus of Port Franqui on the Kasai river down which steamers ply to Leopoldville. The distance from Bukama to the sea by the Congo river is about 2320 miles of which 1800 are navigable. The following table gives details :


SKETCH MAP NO 6
(TO ILLUSTRATE SECTION 6)
KEY
RAILWAY
FRONTIER
IMPORTANT ROAD
" RIVER
SCALE
0 100 200 300 400 500 600 KM
DOUALA
CAMEROONS
YAUNDÉ
RIO MUNI (SPANISH)
PORT NOIRE
FRENCH EQUATORIAL AFRICA
BRAZZAVILLE
MATADI
ANGOLA (PORTUGUESE)
LEOPOLDVILLE
RIVER OUBANGUI
RIVER CONGO
BELGIAN CONGO
RIVER KASAI
BANGASSU
AKETI
YANGAMBI
STANLEYVILLE
PONTHIERVILLE
RIVER ITIMBIRI
PAULIS
MUNGBERE
IRUMU
LAKE ALBERT
NIMULE
SUDAN
JUBA
KAMINA
BUKAMA
KONGOIO
KABALO
KINDU
RIVER LUALABA (UPPER CONGO)
RIVER LOWA
GOMA
COSTERMANSVILLE
UVIRA
ALBERTVILLE
LAKE TANGANYIKA
KIGOMA
TANGANYIKA
LAKE KIVU
LAKE VICTORIA

Reach	*Length in Miles*	
	Navigable	*Unnavigable*
Bukama to Kongolo	400	
Kongolo to Kindu		222
Kindu to Ponthierville	200	
Ponthierville to Stanleyville		78
Stanleyville to Leopoldville	1100	
Leopoldville to Matadi		230
Matadi to the Sea	100	

Metre gauge railways have been built on the left bank round all three unnavigable reaches.

The north-eastern corner of the Belgian Congo lies outside the tropical forest that covers most of the country, and the lateritic soil has made it possible to develop a good system of roads in this region. The Vici-Congo company operates a fairly extensive service of post lorries over these roads, and has also constructed a narrow-gauge railway to open up the district. This line starts at Aketi, a port on the Itimbiri river about 120 miles above its confluence with the Congo; it runs eastwards for 350 miles to Paulis and on for another 80 miles or so to Mungbere. Paulis lies between Juba and Stanleyville about 400 miles from either, and is probably the most suitable point of departure for an extension of the railway to Juba. The distance to the sea by this route would be rather under 2,000 miles, which is somewhat less than the distance by Stanleyville given in the previous section. Nevertheless the Stanleyville route has the important advantage that it provides an equally good connection with the Rhodesias and the Union of South Africa. If a railway from Juba to Stanleyville were built with a gauge of 3 feet 6 inches, the additional work required for a through connection to Cape Town without break of gauge would be to bridge the Congo at the falls just above Stanleyville; to convert 300 miles of metre gauge line to a gauge of 3 feet 6 inches; and to construct about 500 miles of new railway, consisting of 200 miles between Ponthierville and Kindu and 350 between Kabalo and Kamina. According to a recent press report work on this last section will shortly be started.

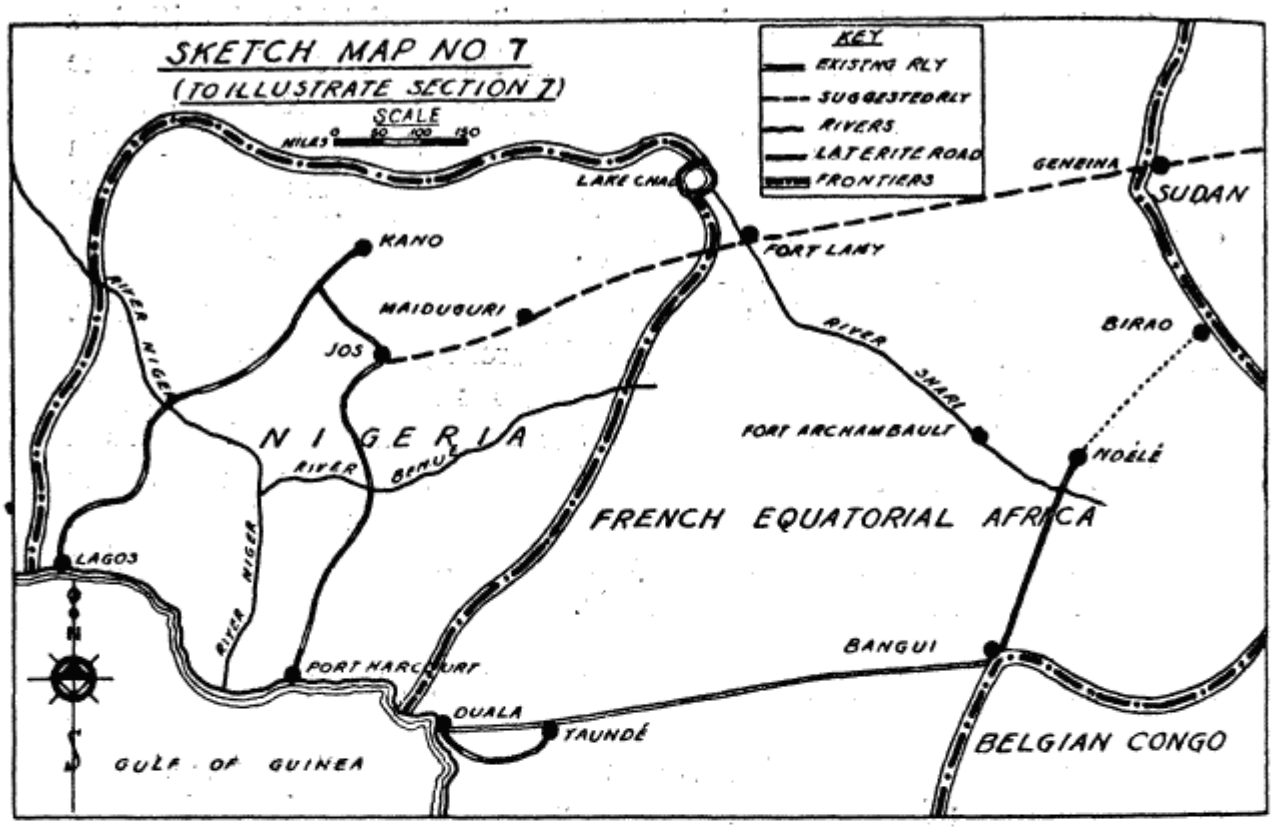
It has already been pointed out that the natural outlet from Juba to the sea is not through the Congo valley. A railway to Stanleyville must therefore be justified for some other reason, if it is to be built at all. One possibility is that it might be found worth while to extend the existing Vici-Congo railway further in order to open up new country in

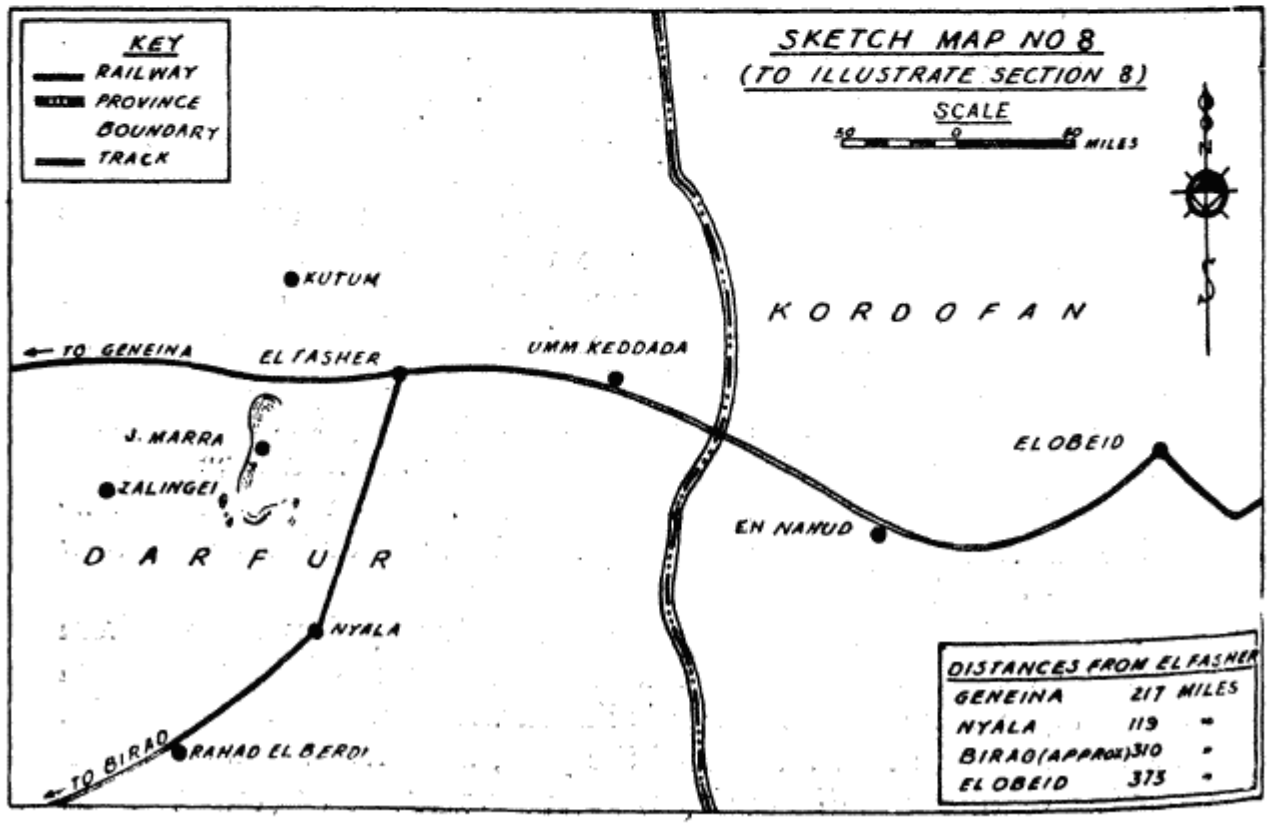
the Belgian Congo. A second is that the railway might be justified as a link in a transcontinental chain of communications stretching from the mouth of the Congo on the Atlantic Coast to the seaport of Mombasa on the Indian Ocean, and incidentally providing the south Sudan with two alternative outlets. Another point to be considered is the advantage of an outlet on the west coast of Africa compared with the east. In certain circumstances this might result in a great saving of ocean-going ships, and how important this can be we learned during the recent war. If, therefore, a railway is eventually built from Juba to a port on the Congo river or one of its tributaries, the reasons will probably be largely strategic. This does not mean that the Sudan would not derive a considerable benefit from its construction, but it does mean that she could hardly be expected to meet more than a small part of the expense. The length of line on Sudan territory would be about 130 miles, costing perhaps one and a half million pounds.

7. A Link with French Equatorial Africa. (See Maps 7 and 8).

French Equatorial Africa is not much smaller than the Anglo-Egyptian Sudan ; if the French Cameroons are included, it is considerably larger. Our common frontier with this territory is longer than that with any other of our neighbours, but most of it lies far from the beaten track. It has, however, alone among Sudan frontiers, been accurately demarcated almost throughout its length. The southern portion follows closely the Nile-Congo divide, though this watershed is seldom marked by any distinctive physical features. The country through which it passes is almost completely depopulated ; there are places where it takes as long as ten days to travel from the last Sudanese settlement to the first village in French territory by the only means of surface transport available, namely walking. In the north the frontier no longer follows the Nile-Congo divide, and laterite bush country gives place to sandy wastes that are no less deserted. Only in south-western Darfur does any appreciable population live near the frontier, and even here local traffic would never justify a railway. From a broader viewpoint, however, the position looks quite different, and we shall now proceed to examine it.

The province of Darfur, though geographically less remote from Khartoum than that of Bahr el Ghazal, is even more difficult to reach by ordinary surface routes. Wau is linked with Juba by a good motor road that is open at all seasons of the year, and river boats can reach it for two or three months during the flood season. For Fasher, on the


SKETCH MAP NO 7
(TO ILLUSTRATE SECTION 7)
SCALE
MILES 0 50 100 150
KEY
EXISTING RLY
SUGGESTED RLY
RIVERS
LATERITE ROAD
FRONTIERS
LAKE CHAD
GENEINA
SUDAN
KANO
FORT LAMY
MAIDUGURI
JOS
RIVER NIGER
RIVER SHARI
BIRAO
NIGERIA
RIVER BENUE
FORT ARCHAMBAULT
NOÉLÉ
FRENCH EQUATORIAL AFRICA
LAGOS
RIVER NIGER
BANGUI
PORT HARCOURT
DUALA
TAUNDÉ
BELGIAN CONGO
GULF OF GUINEA


KEY
RAILWAY
PROVINCE BOUNDARY
TRACK
SKETCH MAP NO 8
(TO ILLUSTRATE SECTION 8)
SCALE
50 0 50 MILES
N
KUTUM
KORDOFAN
TO GENEINA
EL FASHER
UMM KEDDADA
J. MARRA
ZALINGEI
EL OBEID
EN NAHUD
DARFUR
NYALA
TO BIRAO
RAHAD EL BERDI
DISTANCES FROM EL FASHER
GENEINA 217 MILES
NYALA 119 "
BIRAO (APPROX) 310 "
EL OBEID 373 "

other hand, the only surface link with the outside world is a very bad road nearly 400 miles long to El Obeid, itself over 400 miles from Khartoum by rail. Thus, although Fasher is only just over 500 miles from Khartoum in a straight line, it takes about 4 days to get there by the surface route. With such poor communications the economic development of Darfur must be severely hampered, and the advantages of extending the railway from El Obeid at least as far as Fasher are evident. There is no good reason to suppose that it would be particularly difficult to build or unduly costly per mile of line, but the total outlay would probably be nearly five million pounds. This is, no doubt, a large sum of money for the Sudan to spend, but it is less than the cost of the Sennar Dam and it is not easy to see how otherwise the province of Darfur is to be opened up.

Darfur has a number of advantages that entitle it to a high place in the list of Sudan provinces. The climate, for instance, is reputed to be much more agreeable than elsewhere in the northern Sudan with the possible exception of the Red Sea hills. Moreover, the southern part of Darfur is well watered by Sudan standards and includes the highlands of Jebel Marra. Apart from the distant Imatongs on the Uganda frontier these are the highest mountains in the Sudan. Here perennial streams are common, water is plentiful, and there is little doubt that many crops could be grown in this district which would not flourish anywhere else in the country. Temperate fruits, vegetables, and other agricultural produce would find a ready market in the well-populated districts of the northern Sudan, and would effect a much-needed improvement in diet. The traffic could reasonably be expected to bear the cost of lorry transport to railhead at El Fasher, for the average distance is only about 80 miles. There can, however, be no possibility of carrying produce by road for a further 400 miles to the existing railhead at El Obeid and selling it in the northern Sudan at an economic price.

There are thus strong arguments in favour of building a railway to El Fasher with the sole object of opening up the hitherto inaccessible province of Darfur. They are reinforced by the desirability on strategic grounds of connecting the railway system of the Sudan with a port on the Atlantic coast of Africa. The nearest suitable port is Duala in the French Cameroons which lies just over 1,500 air miles W.S.W. of El Obeid. During the dry season it is possible to motor from Duala to El Obeid following a 2,000-mile route through Bangui, Ndélé, and Nyala; but during the rains one cannot get beyond Ndélé where the laterite road ends. An alternative to the Duala route would be to connect El Obeid

with the nearest point on the Nigerian railway system; this is the tin-mining town of Jos which lies about 1,600 miles from El Obeid on a bearing slightly south of west. From Duela a metre-gauge line 150 miles long runs inland to Yaoundé, the former capital of French Equatorial Africa.

Although a railway from El Obeid to Yaoundé would be slightly shorter than one from El Obeid to Jos, the difference in length would not be important and the second route offers decisive advantages. In the first place Nigeria is a large and prosperous colony with a population of over 20 millions and a thriving trade in palm oil and other products; it is therefore far more important than comparatively undeveloped and sparsely populated territories like French Equatorial Africa and the French Cameroons. Furthermore a connection with the Nigerian railways, whose gauge is fortunately the same as the Sudanese, would give us direct access to the two well-equipped modern ports of Lagos and Port Harcourt. The natural location for a railway from El Obeid to Jos would be through El Fasher to the Sudan frontier near Geneina, a distance of about 600 miles; then for some 500 miles on French territory to the Nigerian frontier west of Fort Lamy; and finally a last section also about 500 miles long in Nigeria. The country between El Obeid and Jos is remote and sparsely populated, but it does not appear to offer any great physical difficulties. The Shari at Fort Lamy is the only important river to be crossed; it drains into Lake Chad and is navigable during the flood season for 400 miles or so to Fort Archambault. The railway would thus incidentally open up a considerable area of French Equatorial Africa as well as part of the Bornu district of Nigeria. It is unfortunate that Jos lies some 400 miles from the sea, but the numerous advantages of the Nigerian connection compared with one to Duala far outweigh this drawback.

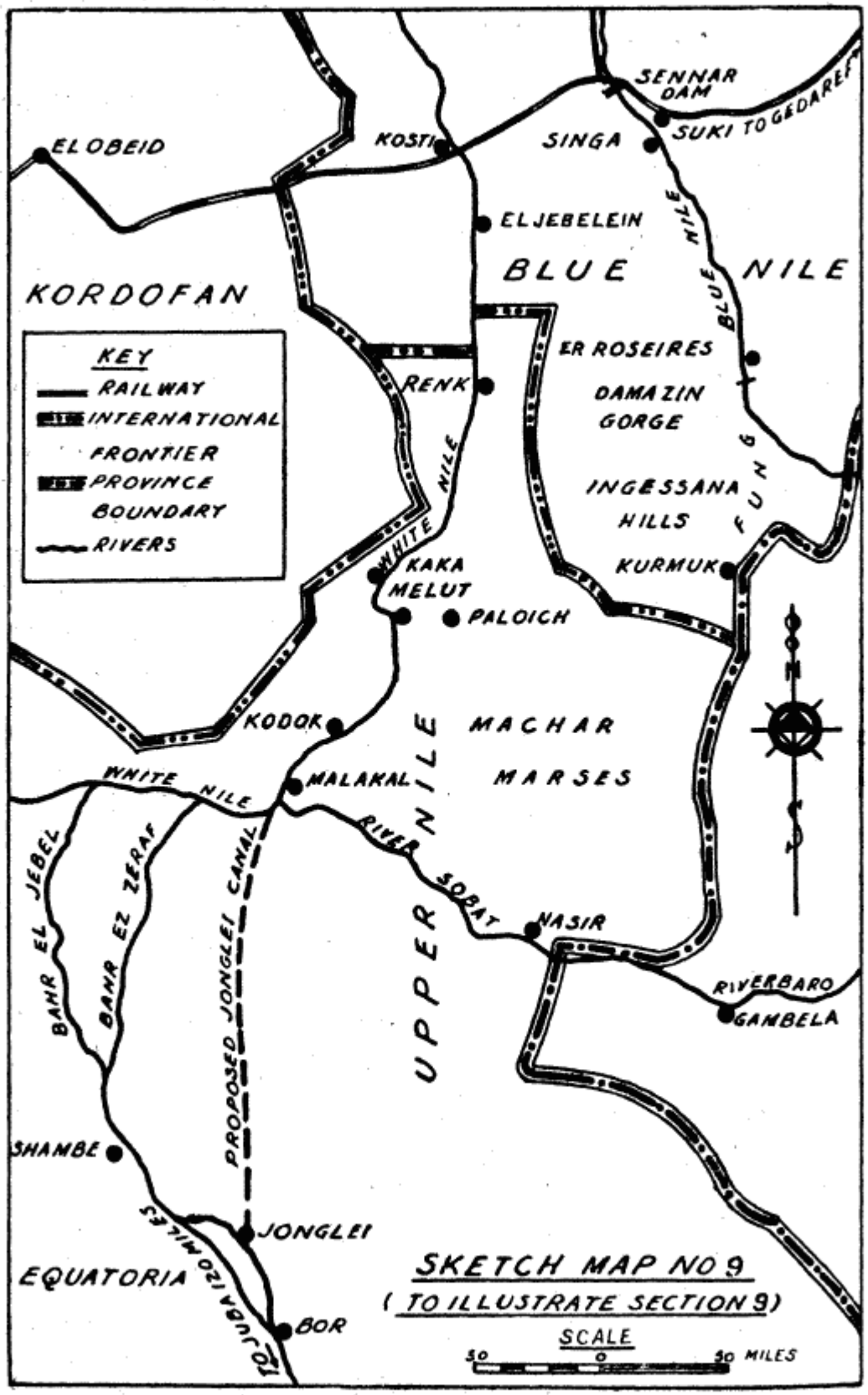
A line to connect the railway systems of Nigeria and the Sudan which followed the suggested location would probably cost little less than 20 million pounds. The main justification for so large an expenditure could only be strategic, though an extension from El Obeid to El Fasher appears to be worth while in order to open up Darfur province. Nevertheless for the section between El Fasher and Jos local traffic could be only on a modest scale. This fact by no means excludes the expectation that the Sudanese-Nigerian transcontinental railway might one day earn a profit. One interesting possibility is the expansion of the pilgrim traffic from northern Nigeria to Mecca; even with the present lack of modern means of communication pilgrims find their way

along this route in considerable numbers, and there is every prospect that these would be multiplied if a railway existed.

8. A Railway from Juba to the Northern Sudan. (See Map 9).

In previous sections we have discussed the possibility of connecting Juba with Uganda and the Belgian Congo in the south. We shall now consider how that town might be connected with the main Sudan railway system, and whether it is likely to be worth while doing so. A railway striking northwards from Juba must be so located as to avoid the extensive marshes that are to be found in the south central Sudan roughly following the ninth parallel. Those of the Bahr el Ghazal and such tributaries as the Jur and Lol extend westwards so far that there could be no question of going round them on this side; therefore the railway would have to be located east of the Bahr el Jebel and of the Bahr el Zeraf. This means a bridge over the Bahr el Jebel not further north than Bor. From here onwards the line must not diverge so far to the east that it becomes involved in the marshes of the Pibor and its tributaries or in the Machar marshes north of the Sobat. Thus, for purely geographical reasons the line must pass near Malakal. Situated on the right bank of the White Nile just below its confluence with the Sobat, this town is by far the most important river port between Kosti and Juba and the natural headquarters of the Upper Nile province. Malakal is, therefore, a key point for the purpose of this discussion; so we shall start by considering the best location between here and Juba.

South of Bor the railway would naturally keep quite close to one bank or other of the Bahr el Jebel; whichever was chosen construction would be quite easy, but the east bank has the advantage of fewer important tributaries. From Bor northwards we should be faced with the problem of constructing a railway across an almost featureless clay plain whose natural slope is so slight and permeability so low that during the rains large areas are flooded. Moreover, it has been found that this region is subject to a peculiar type of flood which creeps slowly over the plain and would play havoc with an ordinary railway embankment across its path. The only solution is an embankment considerably higher than local topography would appear to call for, protected by wide berms and numerous flood openings. Since the soil is pure clay practically all the way from Bor to Malakal, the line would have to be well ballasted in order to keep it open throughout the year. Such a combination of heavy earthwork, numerous culverts or bridges, and a generous supply of good ballast, would make this railway


SENNAR DAM
SUKI TO GEDAREF
EL OBEID
KOSTI
SINGA
EL JEBELEIN
BLUE NILE
BLUE NILE
KORDOFAN
KEY
RAILWAY
INTERNATIONAL FRONTIER
PROVINCE BOUNDARY
RIVERS
ER ROSEIRES
RENK
DAMAZIN
GORGE
INGESSANA HILLS
FUNG
WHITE NILE
KAKA
MELUT
KURMUK
PALOICH
KODOK
MACHAR MARSES
WHITE NILE
MALAKAL
RIVER SOBAT
NASIR
BAHR EL JEBEL
BAHR EZ ZERAF
PROPOSED JONGLEI CANAL
UPPER NILE
RIVERBARO
GAMBELA
SHAMBE
JONGLEI
EQUATORIA
120 MILES
BOR
SKETCH MAP NO 9
(TO ILLUSTRATE SECTION 9)
SCALE
50 0 50 MILES

expensive to construct. Should the Jonglei Canal be in existence, however, its right bank would form an ideal location, being amply large enough to resist creeping floods; in this way much money could be saved.

But what, it may reasonably be asked, is the point of building a railway that runs alongside a navigable canal for nearly 200 miles? The reply must be that, as far as local interests are concerned, there is no point whatever. Such produce as this region may be able to supply will always be much more economically exported by water than by land, particularly after the Jonglei Canal has been built. Consequently the Juba-Malakal railway can be justified only as a link connecting the north Sudan with the southern part of the country and hence ultimately with other parts of Central Africa. It would involve a bridge over the Sobat near its mouth; like any built over the Bahr el Jebel north of Juba or over the White Nile, such a bridge must open to allow river traffic to pass. The practical alternatives are a swing bridge as at Kosti, or some type of lifting span. The line would be nearly 400 miles long, and would probably cost about four million pounds even if advantage were taken of the Jonglei Canal bank.

From Malakal northwards the shortest and most obvious railway location is to follow the river for about 300 miles up to the Kosti bridge, cutting off the Kaka bend on the way. To parallel a navigable river for such a distance is, however, clearly undesirable; a location that would open up some hitherto inaccessible area is to be greatly preferred. There is therefore much to be said in favour of a recent proposal to build a railway from Sennar or Suki through Roseires and Kurmuk to Malakal. If Suki were preferred to Sennar as a point of departure, the line would be 40 miles shorter; on the other hand it would have to be carried across the Blue Nile. A few miles south of Roseires this river flows through rocky narrows, and there is an excellent bridge site not far from Damazin. Roseires itself lies on the east bank of the Blue Nile and would thus be served directly by a railway which followed that bank from Suki to the Damazin bridge. An east-bank location has the further important advantage that it would reduce the distance from Malakal to Port Sudan by 70 miles. The village of Kurmuk lies on the Ethiopian frontier about 230 miles south of Suki and half that distance from Roseires; the distance to Malakal is just over 170 miles in a straight line, and about 213 by the present road through Paloich which skirts the area most liable to be flooded. Thus a railway from Suki to Malakal would be over 400 miles long and would cost about five million pounds.

To this proposed location the objection may be raised that it

follows the course of a navigable river as far as Roseires. This is true, but the Blue Nile can be navigated for only about five months of a normal year and even then with some difficulty. Moreover, as there are no locks in the Sennar dam, it is an isolated stretch of navigable waterway. For these reasons its duplication by a railway could not be regarded as in itself uneconomic. The next objection questions the potential value for development of the Fung country between Roseires and Kurmuk. To the casual observer it does not appear to be a very promising area, but no doubt something could be made of it. Small flush irrigation schemes might perhaps be developed on the torrents that descend from the Ingessana Hills, thus increasing the area at present watered by natural spill and probably improving yields. Finally it may be suggested that the Machar Marsh area lying between Kurmuk and Malakal is of little value. This region is at present almost unknown, but it may have considerable possibilities, for unlike most parts of the Sudan it is well watered. Whether these can be developed at reasonable cost is a question that cannot be answered without much further investigation. There will, it is hoped, shortly be available an accurate map of the area based on air photographs; this is an essential preliminary before any scheme of development can be formulated except in the vaguest terms. Later it may perhaps be found that the Machar Marsh Development Scheme constitutes the principal justification for the Malakal railway.

About the year 1930 a proposal was seriously considered for building a branch southwards from the El Obeid line to serve the Nuba Mountains. Eventually such a railway might have been extended to reach the left bank of the White Nile opposite Malakal. The importance of the Nuba Mountains district makes it seem probable that a railway would be justified despite the fact that the scheme proposed nearly 20 years ago was abandoned. Whether an extension to Malakal could be worth while is, however, very doubtful.

(To be Continued)

CUSTOMS OF THE WOMEN OF OMDURMAN

Part II.[1]

By S. Zenkovsky.

Married Life and Pregnancy.

THE BEGINNING OF MARRIED LIFE.

WHEN the exciting time of the wedding festivities is over and the bride has been definitely handed over to her bridegroom, the newly-wedded couple settle down to a more or less normal life. Still, for the first few months the bride is required to show great shyness; she must resist every approach of her husband and may not speak to or look directly at him. When this period is at an end the husband, if he is pleased with her, must give her a present, and from then on the wife, if she considers the present adequate, will behave in a normal way to him, but on no account is she ever allowed to eat or drink with him, or even in his presence, nor may she mention him by name or address him by his name.

If the bride has been moved to her husband's house, and her mother-in-law is pleasant to her, she may be spared the heavy household duties so that she may not tire herself, but be able to rest and produce a healthy child.

STERILITY.

A barren marriage is a ground for divorce. Therefore all married women wear charms and spend much money seeking the help of a *faki* or a *shaikha* (magicians). If a few months after the consummation of the marriage the woman is not pregnant she will begin to look around for help. She may seek a *hijāb* (a charm containing magical prayers) from a *faki* on condition that the privilege of cutting the hair of the infant for the first time is reserved for him. (This is because of the money involved in the ceremony). Sometimes it happens that the family move from the place where the *faki* dwells and the child acquires a skin disease which necessitates shaving its head, but the mother will stubbornly resist any suggestion of shaving it off. Sometimes a compromise is found by leaving a tuft of hair on a healthy spot for the *faki* to shave eventually, and all the rest is removed. At the age of seven months, which is the time appointed for the first cutting of the

[1] The first part was published in volume XXVI, Part 2 (1945).

hair, the mother with the baby and some relations, preferably her own mother or some other old *haboba* (elderly female relative), will travel any distance to the house of the *faki* to fulfil the imposed condition.

If after one or two years of married life the woman is still not pregnant, more serious measures will have to be undertaken. Some Nile water is brought and poured over the woman seated in a *tisht* (large flat basin). After being dried and clothed she presses a cupful of the same water to her womb under her clothes.

More potent results are to be expected from a pilgrimage to the Khalifa's house or to the Mahdi's tomb during a moonlight night. In the former case in daylight the patient is suddenly confronted with the statue representing an old warrior brandishing a sword. This is done " to frighten her to pregnancy," as they say. Another method is to hold a cupful of river water with some rusty nails in it under her clothes, pressed to her womb ; her legs are slashed with a razor blade and she has to walk to the old cemetery outside Omdurman.

Sometimes the woman, surrounded by relations or friends with the *shaikha* to officiate, is taken for an outing in a boat to the junction of the two Niles. When her attention is diverted the *shaikha* suddenly cuts her leg with a razor. There is a story of a woman who, after giving birth to a boy and remaining sterile for ten years afterwards, having successfully undergone the 'river boat treatment,' became pregnant and was diagnosed as having twins. Suddenly she had a miscarriage during the fifth month. When the *shaikha* was asked : " Why didn't you bind her properly ? " She answered mischievously : " And did so-and-so pay me properly ? "

PREGNANCY

It is considered inadvisable to announce the early time of pregnancy for fear of the evil eye (*'ain hārra*). Until the embryo is six months' old the woman has to submit to her husband's conjugal rights, but from the beginning of the seventh months she must refuse him or general opinion says the child will be born " unclean."

As soon as the husband is notified that his wife is with child he must be very careful not to kill any living creature. By taking life he may kill the child in his wife's womb. Butchers therefore are never young men who may have pregnant wives. They can sell meat but the actual killing is done by old men whose wives have passed the time of bearing children. Even the injury of a living creature by the father of the future infant is supposed to injure the child too.

There is a story of a man who coming home from a *dhikr* (religious gathering) had to pass a lonely spot of deserted land. Suddenly a snake crossed his path and he struck at its head twice with his stick but did not kill it and the snake escaped alive. His wife was at the time in the last month of her pregnancy and later gave birth to a baby with two big red weals on its head.

A man who has been away on a journey and afterwards hears that his wife is pregnant, in order to be certain that he is the father of the child, will take a cat, dog or sheep and incise the ear or the lip of the animal. If the child is his it will bear, when born, a red mark on the place where he injured the animal.

In the seventh month of her pregnancy the woman may claim to return to her mother's house to have her confinement under her care. Usually the request is granted by the husband even if it involves a river or train journey. But if her travelling is out of question, her mother will come to her, especially if it is her first-born (*al bikr*).

THE CEREMONY OF THE *ROB*

Between the seventh and ninth months of pregnancy the ceremony of *rob* is performed. If this ceremony is omitted the woman will have an accident or a very difficult delivery. The word *rob* means sour milk. All the women relations, friends and neighbours are invited ; tea, coffee and soft drinks are offered and food is prepared. An *'anqarib* (bed) is placed in the middle of the *hosh* (courtyard) facing east. In some cases nobody is allowed to stand on this side. On the *'anqarib* is placed a sheet, if possible embroidered. On the sheet, which hangs low, a mattress is spread covered with the ceremonial green and red mat. The future mother, wearing a clean dress and white *tob* (outer wrapping) with newly plaited hair, sits on the *'anqarib* facing east. She wears only her own gold, nothing may be borrowed for this occasion, and a long string of beads (*sumīta*). On her left hand she has a string of beads interlacing her thumb and forefinger and making a bracelet on her wrist. It is called *wush-hata* and consists of green and brown beads with one cowrie shell (*wada'*). On the right side of the *'anqarib* a small table is prepared with *hugs* (wooden box with cover) containing *rīha* (scent), saucers with oil, beads, red silk and ten big iron needles. The *rīha* consists of : sandal wood pounded fine with some *qurunful* (cloves) also pounded, all is sprinkled with scent and this *rīha* is called *darira*. Two or three women of the family are asked to officiate. A dish of *dihn* (ointment) specially prepared beforehand is now placed on the

mattress in front of the pregnant woman. The ingredients of the *dihn* are: simsim oil, *wadaq* (fat), *sandal* (sandal wood), *qurunful, dufra surratia, magmū'a* (kinds of scent), *mahlabiyya* (seeds), all boiled together. The older women begin to murmur prayers or incantations and one of them dips the two hands of the pregnant woman in the dish and smears her head, feet and arms with the *dihn*. This is done three times. The head is next covered very thickly with the *riha* from the *hug* making a pinkish cap. A leather thong called *sirr* and embroidered with cowrie shells in threes is bound on the brow: on her neck the woman wears a golden guinea against the evil eye. Next a big iron needle threaded with red silk is fastened over the right ear. Those who are rich enough have silver needles with a crescent moon on the tops with six silver chains, up to one foot long, hanging from it. Every chain terminates with a silver cowrie shell. Very rich people have needles and chains of gold.

A long string of small cowrie shells plaited together called *tamima* is fastened behind on the top of the head to hang down with the tresses. Next comes the *jirtiq* which is the same as that worn by a bride. Beads, bangles and needles threaded with red silk are taken by guests present, or sometimes sent to absent ones, to be returned on the day of the confinement with gifts of money which is given "for milk." The needles are stuck in the wall over the *'anqarib* of the *nafāsa*[1]. Only women with children of their own may take these needles. After the dressing ceremony is completed three, five or six women are asked to be the first to partake of the *mulāh al rob*. This consists of sour milk called *leban zabādi* or *rob*, onions, pounded *lūbia* (beans) and *waika* (dried hibiscus pods), all boiled together. This mixture with the addition of hot *samna* (clarified butter) is poured on the *'asīda* (millet porridge). After eating some of it these women wipe their hands on the naked abdomen of the pregnant woman, and then the dish is offered to all guests present.

Karāma or *sadāqa* is always given to the poor on this occasion. These two words mean "giving alms," which is performed at any ceremony or celebration. An animal is killed, sheep or ox, depending on the wealth of the givers: the poor are fed with meat and *kisra* (millet bread) and sometimes money is given. The needle stuck over the right ear on the head of the pregnant woman will be worn up to the seventh day or after the birth of the child, but it must be removed before the forty days are over.

[1] *Nafasa* is derived from *nafas* 'to be confined,' in this case connected with *nafs* meaning 'blood.'

During the fast of Ramadān the pregnant woman goes on fasting but if not feeling strong enough she may stop with her husband's permission. She has to fast after Ramadān, for the number of days she missed, any time she feels better[1]. If the child is born during Ramadān and it is a son she continues her fasting, but if the newly-born is a girl she must stop, since the girl is considered weaker than the boy.

The Maternity School in Omdurman, founded by the Misses Wolf, is carried on by government midwives who attend to the ante-natal clinics. The delivery, except very difficult or abnormal cases requiring a doctor's help and hospital treatment, is performed in the patient's home by capable trained district midwives. Before the time of the Misses Wolf, and even now in villages without trained midwives (*dāyāt*) the delivery was performed by old *habobas* and the patient was suspended by ropes to the ceiling.

If the woman has not delivered at the normal time of nine months' pregnancy she is suspected of having eaten camel flesh which causes the delay. To overrule this bad influence a she-camel is brought to the *hosh* (compound) and the pregnant woman has to crawl under its belly.

THE CONFINEMENT

As soon as the pregnant woman feels the first pains heralding the "big event" she sends for her *dāya* who has been engaged long ago and is expecting the call. She arrives with her maternity box and two or three pupils from the midwifery school and delivers the patient easily.

All the women in Omdurman and the northern Sudan are circumcised at about the age of ten and therefore during the last stage of labour the *dāya* has to cut the perineum to allow the baby to be born. The mother is sewn up at once after the delivery and gets gifts of money, clothes and scent from her husband as a reward for extra pain.

All the time during the labour and birth the woman must be silent and never cry out even if it is her first-born, otherwise she will be the laughing stock of all her friends, especially of her girl friends.

Privacy during confinement is unknown. A crowd of mothers, sisters, grannies, aunts, with a sprinkling of very near friends and even children, throng the room, chattering, giving advice, encouraging the sufferer and helping. The *hosh* outside is crowded by well-wishing neighbours who have to be present. The same noise goes on after the

[1] The same permission is applied to women and girls having menses on condition that they complete the fasting days afterwards.

delivery, robbing the mother and child of a well-deserved rest: in the case of a first-born son the female relations utter the *zaghārīt* (joy-cry).

The advent of a girl is greeted in silence, but the child is usually welcomed with the same pleasure as a boy. Many women deplore their misfortune if they give birth to two or three boys in succession, as a first born girl growing up is a great help to her mother in her household duties.

The Sudanese love their children and very often a happy father is seen parading the streets with an infant son or even daughter in his arms. Cases of cruelty to children happen very rarely and then only if they have a step-mother or the husband has taken a second wife. An orphan will be willingly taken by relations or even by neighbours: adoption of children from hospitals in case of illegitimate birth, or of foundlings, often occurs.

Sometimes from a big family with many children a boy or a girl will be taken off by an aunt or grandmother, brought up, educated and married off by them. There is a story of a girl belonging to a tribe of nomad Arabs who, attaching herself to a newly wed bride, left her tribe and settled down in the *hosh* in the capacity of half-servant, half-friend. In the family of eleven children she adopted one of the boys and brought him up as her own. When she died of old age the boy, by then aged fourteen, mourned her as if she were his own mother.

AFTER THE CHILD IS BORN

As soon as the delivery is finished and the room tidied up, the mother is rested and dressed in a new dress (a present from her husband). As it is considered unlucky to prepare anything for the baby beforehand, the new born infant is wrapped in soft, clean rags and lies near its mother. A Qur'an wrapped in a handkerchief is put on the *'anqarīb* with a *mirwad* (an iron or copper rod about 10" or 8" long). In the case of a first-born the mother puts on her gold ornament and wraps herself in her bridal tob (*firka jarmasīs*) and her *'anqarīb* is covered with the ceremonial multicoloured mat. On the table near her *'anqarīb* is placed a plate with *'aish* (millet) whilst a spear with a little white rag on the top of it (if a boy was born) is stuck in the corner of the *'anqarīb*. Sometime, depending on the tribe's customs, a knife is left lying on the *'anqarīb* itself. The mother and the child are never left alone in the room and every precaution is taken against the *umm as-subyān*, an evil being who is supposed to exchange the new-born infant for a *shaitān* (devil) or put a spell on it making it a complete idiot with protruding eyes and

hanging-out tongue. Since inter-marriage between first cousins takes place very often, the considerable amount of feeble-minded and even degenerate people may be due to this and supports the belief in the superstition.

The Qur'an is supposed to guard the child from the *umm-as-subyān* ; whilst the *mirwad* preserves the mother from the *shayātīn* (plural of *shaitān*). She has to carry the *mirwad* even to the latrine with her. For forty days the mother rests on her *'anqarīb* without working and is looked after by her family or near relations. The child is never taken out during the forty days but if it falls ill and has to attend a clinic the *mirwad* is carried with it. On the third, fifteenth and fortieth days the family of the new-born child has to give *karāma*. On the third day *madīda*, a sweet porridge of crushed dates, is prepared and sent to friends with biscuits shaped like fingers, and oil for making *dihn abyad* (white ointment). The midwife usually attends the mother and the baby for seven or ten days. On the seventh day some *kuhl* or antimony black is applied to the child's eye. A cross is traced on the brow if a boy and two or three stripes on the temples if a girl.

The seventh day is called *simāya* or naming day ; until then the parents do not like to give out the baby's future name. Relations, friends, neighbours gather together with offerings of money to celebrate it : tea, coffee and soft drinks are offered, and dates and sweets eaten.

On the fifteenth day after the birth of a son, and on the twentythird in case of a daughter, the mother has her smoke bath. Since she cannot leave her own room for long, a new hole is dug out in the same. On the fortieth day after delivery the mother and child must go to the river. Relations, friends and neighbours gather together at sunset, while a big dish of *balīla* is prepared : it consists of two kinds of beans, maize and *lubia* soaked in water and boiled soft. Some dates and sweets are put in a basket.

The *nafāsa* (the mother of the baby) carries the *mirwad* and a little bottle of *kuhl*, the baby is carried by some attendant and so is the dish of *balīla*, dates and an old petrol tin with all the rags used in cleaning the baby during the forty days. The procession goes quietly on, joined up on the way by friends who wait at their houses if they live along the processional route. As the *nafāsa* is usually feeling very weak after 40 days of imposed immobility, she moves rather slowly and usually is at the end of the crowd, but at the river bank everyone must wait on the shore until she arrives and enters the river. Stepping ankle deep in water she throws into it a handful of *balīla*, washes her hands, face and feet and comes out. Then the woman who is carrying the baby,

usually the sister or a very near relative, enters after her, throws *balīla* on behalf of the baby and washes it in the same way. The other relations now throw dates and stones in the water and after this everyone must wash hands, faces and feet; some go bathing. The people who do not enter the river have water brought to them in handfulls. Meantime the *nafāsa* with the baby on her lap is sitting quietly on the shore applying *kuhl* to her eyes with the *mirwad*. Afterwards the *kuhl* and the *mirwad* are passed on to near relations. After enjoying themselves in splashing and rejoicing the whole crowd partake of *balīla* and dates, and every woman passing by is invited to join in the feasting. When they have finished eating, the tin with the soiled rags is emptied in the river, and then the *nafāsa* gets up, says *bismillāhi* (invocation of the name of God) and quietly starts back home. All the crowd is invited to have tea and coffee in the house.

If during the forty days a death occurs in any of the neighbouring houses, the *nafāsa* cannot attend, but she must go immediately after the river ceremony to join in the mourning.

After the child is forty days old, a string of beads is put round its stomach: the beads need not be of a special colour and may consist simply of a leather throng with only one bead. This is called *hagu* and is supposed to hold the milk the baby sucks from its mother.

When the child is seven months old, its hair is cut for the first time, but a tuft is left for the *faki* to cut off with a prayer. At about the seventh or eighth month the child will have incisions made on its temples, three in a row: some tribes make marks with a hot iron on the brow and neck and two vertical signs on each temple.

At the time of teething the child gets a hard vertebra of a special fish; this comforter is called *rad'a* and together with a small piece of goat's skin saturated with scent, hangs on its chest. If the child is late in teething three cuts on both knees are done by an old *haboba* who has a light hand and *atrūn* is rubbed in. If difficulty is experienced in the cutting of the four eye-teeth, the tomb of Sheikh Khōjali in Khartoum North is consulted; prayers are recited by the present-day descendant of the sheikh who collects the money-offerings which are dropped into a box on his tomb.

THE ZANDE SCHEME

By Major J. W. G. Wyld.

(We print below a shortened version of a paper read at the Colonial Department of the Institute of Education of London University in 1948).

THE BACKGROUND OF THE AZANDE

INTERNATIONAL boundaries are by no means the boundaries of the Zande tribe. In the Sudan there is a Zande population of about 200,000; in the Belgian Congo there are probably twice that number, and in French Equatorial Africa there are a matter of about 25,000 to 30,000.

The tribe as constituted today is not racially pure, but contains a large admixture of smaller races who have been enveloped and absorbed by the Azande; but on this subject I shall have more to say later. Within the Sudan, Zande country extends over some 30,000 square miles, but there are many square miles of it to the north and north-west which are completely unoccupied at present.

Zande land is very near the centre of Africa. It is also remote from natural communications in the shape of navigable waterways. It is 330 miles from Juba, which is the most southerly navigable point on the Nile within the Sudan, and the same distance from Wau which is the southernmost navigable point on the Jur River, a port only open for two or three months a year during the high flood. Juba is roughly 1,700 miles from Port Sudan and 1,800 miles from Wadi Halfa. There is an important road linking Juba with Uganda, and the distance from Yambio to Soroti which is the terminus of the Kenya and Uganda Railway is about 700 miles. Soroti is about 800 miles from Mombasa. From Juba there is also an important main road westwards to the Belgian Congo, but here again the distances to any main navigable water-way or railway are immense. This remoteness has a direct bearing on the conception of the Zande Scheme.

As to the Zande country itself, it is best described as " grassy woodland." It has an average rainfall of 55 inches a year and frequently gets 60 or even 70 inches a year. The best description of the country that I know is contained in Dr. Junker's " *Travels in Africa* 1879-83."

On the Nile-Congo divide which is the boundary of the district with the Belgian Congo and French Equatorial Africa over a distance of about 200 miles, there is much gallery forest, containing lofty rain forest trees such as *Khaya Grandifolia*, *Chlorophora*, *Canarium*,

Erpthrophlaeum, *Afzelia*, *Cola*, *Mitragyne* and many others. Traces of rain forest exist between the gallery streams. Large areas are well wooded with fine secondary forest species such as *Anogeissus*, *Terminalia*, *Daniellia*, *Vitex* and others. Travelling northwards, the better forest gradually gives way to more degraded types of bush, but these more northern areas also contain fine stands of *Berlinia*, *Irvingia*, *Anona* and again many other trees, especially along the rivers, where the destruction wrought by man has not been too complete.

The rainy season commences early in April and usually continues until early or mid-November. There is little or no rain in December. January and February, except for occasional showers. There are usually a few heavy showers in March.

In the " green belt " or southern and more fertile areas, there is a network of small streams forming the tributary system of the main rivers, which are the Iba and the Sue. The majority of these tributary streamlets dry up in the height of the dry season, but water can be found in shallow wells of 4 or 5 feet depth, sunk in the stream beds. It is from such points that the Azande draw their water supply during the dry season. A few favoured streams flow all through the year, and the two main rivers have a modest flow throughout the seasons except in years of exceptional drought, when they shrink into a chain of pools for a short time, though there is probably a permanent flow through the sand in their beds.

In the rains these two rivers are a noble and imposing spectacle, though numerous large and rocky barrages render them useless for navigation. It is conceivable that they might be used for rafting timber down stream during the high flood if timber should ever be produced on a commercial scale.

Generally speaking, the country is gently undulating and there are no important hills or mountains. There are, however, minor outcrops of grey rock here and there which form small hills and ridges. The predominating stone of the country is red ironstone. There are frequent outcrops of this rock in shallow shelf-like formation. It can always be found by digging to depths varying from a few feet down to as much as 40 or 50 feet. Above the ironstone there is usually a strata of gravel or pea-iron, red in colour and very useful for road construction.

The country as a whole is heavily bushed. Amongst the commonest species in the scrub bush are many forms of *Combretum*, *Anona Senegallensis* (the wild custard apple), *Grewia Mollis* (from which the Zande make their salt), *Sarcocephalus* (a very decorative flowering bush) and many others. In this type of bush are to be found small brakes

of larger trees such as *Acasia Campilocantha, Acasia Siberiena, Sterculia, Lophira Alata* and innumerable others.

Grass grows to a height of 10 or 12 feet in the rains, so that when motoring in that season, you get little view except on the higher levels. When the dry season sets in, the grass and bush is burnt off and the air is thick with smoke and charred grass particles for a time. Bush burnt early soon resumes a green appearance, and the regeneration of short grass and budding trees, of which there are many flowering species, imparts a very attractive appearance to the countryside.

No general description of Zande land would be complete without mentioning the mango tree. This plant was introduced from the Congo 30 or 40 years ago and has thrived in no uncertain manner. Avenues of mangoes are now a feature of most of the roads and they have seeded and increased. They bear enormous crops of fruit, free for all in unlimited quantity, a very wholesome and admirable addition to the diet.

The variety of cultivated and edible plants and crops in this area is prodigious. The grain is eleusine or finger-millet. Other grains grown are maize, a little ordinary millet, bulrush millet and rice. The main root crops are cassava and sweet potatoes. Ground nuts are universally grown in large quantities and form one of the most important articles of diet. There are at least half a dozen varieties of beans; sesame thrives, particularly in the dryer areas. The commonest fruits are mangoes, bananas, pineapples and limes. All forms of citrus grow readily. The oil palm thrives in the "green belt," though it is not indigenous. *Robusta* coffee can be grown with success. There are many forms of native vegetable including pumpkins, marrows, yams and various kinds of spinach.

There is one great deficiency in the native diet, and that is meat. The Azande have no domestic animals at all except chickens and dogs. The chickens are of a particularly miserable and stringy variety and are mainly used for consulting the oracles. Dogs are greatly valued and used for hunting: they are not eaten, as certain inaccurate historians have claimed in the past. The Zande dog is a jolly little beast, usually chestnut or chestnut with white points: he has a curly tail and does not bark or smell.

Nature provides a limited supply of animal fats and proteins in the shape of the flying termite. At the seasons of the nuptial flight of the various species of termite, the whole population is engaged in their collection. This is done by night with the aid of fires and torches, and a large harvest of many millions of the creatures is gathered. They

are either reduced to oil, of which they are full, or fried up into a porridge-like mess.

So deep-rooted and acute is the craving for meat, that the Azande have hunted and destroyed most of the common game in their country. They hunt with nets, dogs and spears. In the past they hunted with ring fires and pit traps, but such barbarous practices have been made illegal, and, though not quite extinct, are greatly reduced. Hunting with nets is forbidden during the dry season. In the thicker and more remote forests there are a few very rare species of game such as the bongo, the giant forest hog, the yellow backed duiker and the dry-land sititunga.

There is no ethnological certainty of the origin of the Azande. They are officially described as Central African Negroid. They are a sturdy race of medium to small stature with good torsos but rather short in the leg. In colouring they are chocolate rather than black. In their unsophisticated state the men wear pants made of bark-cloth, and the women wear bunches of leaves, suspended from a girdle, fore and aft.

Many thousands have been converted to Christianity during the past thirty years. It must, however, be realised that old customs, superstitions and beliefs die hard. Here is a race that has been steeped for centuries in a deep-rooted belief in black magic and the evil eye, as well as customary tribal prophylactic magic[1]. No step in life of any significance is taken without consultation of the oracles. With such a background it would be unreasonable to suppose or hope that the Azande could be freed from superstitious fear in a generation.

There is little known of the history of the tribe dating back beyond roughly 80 years. The first Zande probably entered the Sudan no more than 200 years ago, migrating from the River Mbamu in French Equatorial Africa.

The Azande possess a Royal Family or Clan of Princes. The origin of this clan is shrouded in mystery and legend. This clan of princes provides the chiefs and sub-chiefs wherever the Azande are to be found, whether in the Sudan, the Belgian Congo or French Equatorial Africa, and the family tree is known for seven or eight generations back and can be traced to a common ancestor, which gives colour to the popular belief that the Royal Clan is of foreign and superior origin. However that may be, and whatever the truth, the fact remains that these chiefs of the hereditary Royal Family exert an authority and

[1] See particularly Evans-Pritchard, *Witchcraft Oracles and Magic among the Azande* Oxford 1937.—Ed.

influence, and command a respect that no commoner could hope to do.

There is no doubt that most or all of these old chiefs perpetrated the most bestial and cruel atrocities, yet they wielded unquestioned power, and received a vast loyalty through their genius for organization and conquest.

In the Sudan the first reputed leader was a chief called Nyekpati. He invaded the south-west corner of the Sudan with a considerable following, and proceeded to envelop or absorb the local races, who had evidently no cohesion or will to resist. To mention a few of the races so absorbed, there are the Pambia, Barambu, Buguru, Golo, Basiri, Viri, Madi, Bagbinda and Zuru. None of the races except the Madi put up any resistance at all and today they are absorbed in the Zande way of life ; in some cases even the original language is being lost.[1]

Once having arrived in the Sudan, Zande infiltration and absorption of the countryside continued in all directions and into the Belgian Congo as well. It would have spread much further, had not outside forces come into play. The slave traffic was the first of these forces, followed some years later by the Egyptian Government, and finally by British influence : 1905 was the year of the first British patrol to Yambio. From that date onwards conquest and absorption came to a halt and the present regime was initiated.

From about 1905 to 1914 administration was mainly of the military variety. Law and order on British lines was demanded and the more bestial practices of the chiefs were suppressed. The country was cut up into small chiefships without any paramount head.

About 1917 sleeping sickness and its ravages became known. Thereafter followed an active campaign to counteract the disease, a campaign which has proved most effective. The precautions and regulations imposed were not easy for the Azande and necessitated a regimentation in the shape of inspections, stream clearing and restrictions regarding domicile, which were vigorously enforced.

This intensive medical campaign brought to light many other diseases to which the Azande are heirs, for instance, leprosy, venereal disease and various forms of intestinal parasites. Two important medical centres were formed, embracing settlements for the treatment of sleeping sickness and leprosy[2] and general civil hospital work. The provision of skilled medical personnel was not ungenerous, with the result that excellent medical work was done. Sleeping sickness

[1] See Santandrea, Little-known Tribes of the Bahr el Ghazal, *Sudan Notes and Records*, Vol. XXIX Part 1.—Ed.

[2] *Sudan Notes and Records*, Vol. XXIX (1948) Part 1.—Ed.

was considered completely under control by 1940; for leprosy there is still no known cure. Venereal disease, unfortunately, is still prevalent, as are intestinal complaints such as bilharzia and ankylostomiasis. The last mentioned diseases are all curable and the campaign against them proceeds. Today there is also a network of dispensaries, so that medical aid is within reasonable reach of all.

During these years considerable progress was also made in the process of administration. Chiefs Courts were organised on a territorial basis, where vast numbers of cases were dealt with. Such cases were always subject to appeal to the District Commissioner, who also reviewed and revised all court work. Adequate motor roads were constructed throughout the area.

During the same years Christian missions were active, both Protestant and Roman Catholic. Elementary vernacular schools were set up at various centres under the charge of devoted European missionaries. These centres formed the nucleus of a network of bush schools run by native teachers, which now embrace every corner of the district.

The Government of the Sudan has given the mandate for primary education to these Christian missions and has supported their educational activities with subsidies and grants, while at the same time naturally insisting on the right to direct and inspect their activities on the educational side.

Again during this same period a degree of prosperity in the material sense has developed. Trade and commerce naturally followed the improvement of communications. Starting in a modest manner with a few little shops at the centres of administration, there are now a number of reputable firms each with a network of bush shops, that serve as distributing agencies for such essentials as salt, soap and cheap cloth, while at the same time buying and exporting the articles of local produce that will bear the cost of transport to outside markets. These in the past have been limited to chillies, honey and beeswax.

As an indication of progress in this respect I can quote the following figures of the past 17 years:—

1931	District Revenue	£E.	500
1947	District Revenue	£E.	23,000
1931	Money placed in circulation ..	About £E.	1,000
1947	Money placed in circulation ..	£E.	95,000

THE ZANDE SCHEME

In 1938 Dr. Tothill, who had been for some years Director of Agriculture in Uganda, was appointed in the same capacity to the

Sudan. He was instructed by Sir Stewart Symes, then Governor General of the Sudan, to make a survey of the South and to study in particular the possibilities of agricultural development in that region. Dr. Tothill accordingly carried out an extensive tour of the area.

Valuable data were also obtained by Dr. Myers, an eminent ecologist, who had been engaged by the Sudan Government for a survey of the South, and in 1943, once the tide of War had turned, Dr. Tothill submitted skeleton proposals for the Zande Scheme and carried out another tour and soil survey of the area.

Broadly speaking, Dr. Tothill proposed an experiment on a grand scale in social emergence for a remote Central African tribe, by making the fullest possible use of natural resources. Self-sufficiency was to be developed to the utmost, and overhead expenses on exports, to provide funds for essential imports, were to be reduced as far as possible. In Dr. Tothill's view the solution lay in exporting processed or manufactured articles rather than raw material. Imports should be reduced to such articles as could not conceivably be manufactured locally, or local substitutes provided.

Zande land was selected for the experiment because it was an area where the food problem did not cause anxiety. There are, unfortunately, many areas in the southern Sudan where crops and food supplies are produced on a meagre subsistence basis only. It was clear that no area could be selected for such an experiment if the people did not at least feed themselves properly.

The scheme was favourably received in some quarters. But that there should have been many doubts and even opposition to the proposals in other quarters was inevitable and salutary. The project had to be an act of faith as far as the Sudan Government was concerned. No commercial concern would have considered it seriously for a moment, and it should be remembered that the Sudan is by no means a wealthy country.

The principle of Dr. Tothill's scheme was to produce manufactured goods which were considered to be a reasonable need of the community themselves, and of which the surplus could be exported to provide funds for the purchase of reasonably necessary imports. It was essential to select commodities, the basic elements of which could be grown with success.

For a start these were :—Cotton cloth, soap, sugar, coffee, and of these the most assured and the most important were cotton and soap. Coffee has since dropped out.

In the production of all manufactured articles by machinery there is an economic minimum of the raw material required to run a factory,

below which it is waste of time to operate. Machinery in itself is extremely expensive in these days, prices are ever increasing, and dates for delivery after placing an order are remote and uncertain. Add to this the costs of transport over thousands of sea and river miles, and then hundreds of miles through Central African bush. The last factor alone involves the construction of expensive roads and more expensive bridges. These roads will also be required for exporting the products when manufactured.

Then there is the question of scientific and technical staff. Highly qualified and expensive agriculturalists, engineers and technical experts of many categories must be engaged and housed. Before the majority of these can be located on the required spot, artisans of many varieties must be procured to erect staff housing and to instal machinery. Water must be found and supplies laid on. Medical provision must be made for both foreigners and Sudanese. It is clear that careful planning and great expenditure is involved.

Government officials who knew the Azande best conducted an extensive propaganda campaign, explaining the scope and motive of the proposed scheme. It is to the credit of chiefs and the more intelligent tribal leaders that they supported the project from the first. They promised that if Government produced the opportunity, the Azande would grow the necessary crops. It was with such promises and guarantees that Government had to be satisfied.

It was decided to start with, that cotton must be the primary and most important cash crop. Experiments and experience had shown that this could be introduced at once as a peasant crop. It was felt that further experiments on a considerable scale must be conducted in other crops before they could be included in the normal peasant economy. The crops with which these experiments are being carried out are sugar, oil palms and tobacco. Take sugar for instance; there were, and still are, doubts as to the feasibility of making this a peasant crop for a race in so primitive a stage. Other crops in which limited experiments are being made, but which are of improved economic value, are *Robusta* Coffee and Tung Oil.

It was decided that no extension of agricultural effort was justified without adequate safeguards for soil and water supply and proper agricultural supervision. The soil in Zande land is shallow, light, and somewhat acid. In forest clearings there is plenty of humus, but once the forest and bush is cleared, loss of fertility is rapid and could be disastrous without positive precautions.

The relaxation of sleeping sickness precautions had coincided

with the outbreak of War and reduction of staffs. The result was that the Azande, having been permitted to move out of enforced domicile on roads, very rapidly scattered themselves through the forest and set up house wherever the spirit moved them, making any form of agricultural supervision or control impossible.

The safeguards for soil and water supply in their simplest form were fairly obvious. Cultivations must be made across the slope of the ground and not up and down it. Margins of grass and scrub must be left between strips of cultivation to stop wash. Forests at stream sources must be protected and improved and so must forest fringes along the streams.

Under the circumstances obtaining at the moment of the scheme's official approval, there seemed no conceivable hope of enforcing such safeguards. It was therefore decided that before cotton or any other cash crop could be grown, there must be some form of resettlement.

A resettlement, if wisely planned, would be of inestimable value from every point of view. It was needed in order to strengthen the administrative control of chiefs and headmen, for agricultural control and safeguards of soil and water supplies, in the interests of public health and medical effort, and last but by no means least, in the interests of education and schools.

Resettlement commenced without delay in the dry season of 1946. It was decided to develop resettlement in village groups of approximately 50 families, each under their headman. The village areas were split up into homesteads, which varied in size according to locality. The smallest are 25 acres each, where there is land shortage; the average in the majority of areas is just under 40 acres each. Each homestead is based on a village path, which is made suitable for cycling.

Before resettlement commenced in any given Chiefship, meetings were held of the chief, his subchiefs, and headmen and village elders. At these meetings careful investigation was made of the area preferred by each headman and his followers, and the streams or wells from which they wished to drink. If there were several claims to the same area, the chief and subchiefs had to decide whose claim was the better. It was then necessary to make a rough layout on the map to fit the villages in to best advantage. The next stage was the cutting of pilot lines through the bush to give access to the village areas. These lines and also the village lines must be made with precision and angles must be accurate; otherwise grave errors and confusion arise.

All resettlement in any given year has to be carried out in the dry season, between the time of harvesting the last crop and before the

ensuing rains take place. This means roughly a period of four months. January to April inclusive. In that period pilot lines, village lines, boundaries between homesteads, allocation to families, and the building of houses and grain stores must be completed.

Three seasons of resettlement have now passed :—

In 1946	100	villages	were	completed	for	5,000	families.
„ 1947	180	„	„	„	„	9,000	„
„ 1948	260	„	„	„	„	13,000	„

That is a total of 540 villages, rather over half the total required. I estimate that two years of 200 villages each will complete the job.

To assist and regulate the work, parties of young men are enlisted and given a year's training in siting straight lines and measuring distances with wire measuring tapes. These same young men are put through a season's supervised cotton cultivation. They are also taught the principles of strip cropping which I described earlier. Once the village layouts are complete, these young men are posted to chiefs at the proportion of about one man to three villages, to assist headmen and peasants in all work of supervising agriculture, and particularly to demonstrate the various processes necessary in successful cotton growing.

Following the principle that no agricultural development was justified without proper safeguards and supervision, no cotton planting was started except in the resettled areas. Thus the introduction of the crop has been deliberate and methodical. Three harvests have now passed and results have been most encouraging, the target figure for production having been beaten on each occasion. The proportion of Grade I cotton has been high, and yields per acre, over an area which has increased very considerably each year, have been satisfactory and well maintained. So far it can be fairly said that the Azande have justified the faith which the Government placed in them.

An experimental sugar plantation has been planted over three seasons, and cane has been found to grow in a satisfactory manner. A limited quantity of jaggery sugar has been produced with rather primitive machinery, but the process of expansion has been slowed up for lack of machinery. A small sugar factory has now been obtained. Even with the limited plant that has been available, results have been encouraging and sale of the product has more than paid for the labour and running expenses.

As far as other aspects of the scheme are concerned, progress is being made in spite of the many difficulties and frustrations without which no plans or schemes are carried out in these days.

In view of the fact that the first important agricultural project

in the South was to be carried out in Zande country, it was deemed expedient to locate the principal experimental farm and the agricultural training centre and school for the South also at Yambio. These two institutions are now starting up. The process has involved the selection of suitable scientists and teachers, and the construction of houses both for them and for native teachers and clerks. This work, which is not exclusively for the benefit of the Azande, has proceeded contemporaneously with the work directly involved by the scheme.

In view of the nature of the scheme, it was necessary to create an industrial centre where the factories and machines could be installed. At this centre, housing, both for British and Sudanese staff, is under construction. A cotton ginnery has been installed and is now working, together with workshops and lesser machines. Machinery for the soap factory and sugar factory have been delivered and await erection. The main plant for the spinning and weaving mill has not yet been delivered. About 100 miles of road have been brought up to a good standard, involving the erection of many steel and concrete bridges. All this work has imposed heavy demands for labour upon the Azande, especially when it is realised that the men involved in the season's resettlement are released from all other work.

There are always critics of schemes which involve the social emergence of primitive races. No one who has known the simple African in his primitive state, and has seen the impact of what we are pleased to call civilization upon many of them, can fail to have regrets, doubts and fears. The horrors of urbanisation, the growing pains of semi-education, and the wrong-headedness produced by improperly understood motives, are all very real and very distressing.

I think the sane view in these days is a realisation that no area in the world can be segregated or, if you like, preserved, from the onflowing tide of sophistication and the upheaval of progress.

Our efforts must therefore be concentrated to the utmost on progress in a steady and wise manner, and on laying sound foundations. Only time can prove the success or otherwise of these efforts. We have at least in this scheme one inspiring factor, and that is, the motives are pure.

NOTE.—Attention may also be drawn to a memorandum, duplicated for circulation to Government Departments, entitled " The Zande Scheme from a Survey Point of View " by J. W. Wright, Sudan Survey Department, 1946.—Ed.

AIR SURVEY IN THE SUDAN

By J. W. Wright, M.A.

(Paper read to the Philosophical Society of the Sudan on 26th October 1948).

INTRODUCTION.

It is now ninety years since the first air photographs were taken from a captive balloon in France. Since then millions have been taken from heights ranging up to 30,000 feet; some of them in continuous strips running for hundreds of miles. In the 1914-1918 war, and even more in the last war, their value was realised and their potentialities developed, so that they now form an indispensable tool for many purposes, not only for survey. On the other hand, they are far from being the only solution to many survey problems. In cadastral mapping, for example, where the main object is to find out and demarcate on the ground the property boundaries, aerial photographs may be of little value and not worth the extra expense. In flat and relatively accessible country also, where ground levelling may be comparatively cheap and possibly the only method of producing sufficiently accurate contours for a particular survey, little use can be made of air photographs except for a preliminary reconnaissance. But in topographical work, especially in areas where survey on the ground is difficult because of rough terrain, thick forest, swamps, or other obstacles, air survey is often the only way of producing a reasonably accurate map without prohibitive expense. In the Sudan we have been particularly fortunate in being given copies of a series of American air photographs which were taken during the last war, and which cover something like two thirds of the whole country. For many purposes these photographs are far from ideal, and we are trying to extract from them very much more information than they were intended to give; but they are a tremendous asset and they have turned our attention to air survey in a way which might otherwise never have occurred, because of the normally heavy expense of taking the photographs.

A survey department is a servant and not a master; although it may have a long term programme of mapping it must necessarily depend on the central administration and on the requirements of departments for decisions about which areas of the country require mapping first. The same is true of aerial photography, and it has seldom happened that my department has actually initiated a demand for air photographs. But, once such a project has been started, we

AERIAL PHOTOGRAPHY
OF
THE ANGLO EGYPTIAN SUDAN



Scale 1:8,000,000

Miles 100 50 0 100 200 300 400 Miles

Reference.

RAILWAYS
TELEGRAPHS or TELEPHONES
INTERNATIONAL BOUNDARIES
PROVINCE BOUNDARIES
WIRELESS STATIONS
MOTOR ROADS
LANDING GROUND - IMPERIAL AIRWAYS
OTHER PRINCIPAL LANDING GROUNDS

Trimetrogon photography already plotted in U.S.A.

" " not yet " "

Vertical photography taken & plotted by Air Survey Coy

Miscellaneous vertical photography [illegible]

Major areas already mapped from photography by Sudan Survey Dept

" " being " " " " " "

are usually closely concerned in it, and there are several reasons why we should be included in the planning of it from an early stage. In the first place we can probably help to locate and define the area more exactly by means of more up-to-date material than is shown on the published maps. This lag in the maps must always exist but it is more marked at present than ever before, owing to the existence of a large number of air survey compilations which are too rough to be issued as printed maps without being redrawn. Secondly, the new photography will almost certainly be of value for correcting the existing small scale maps, which are in many cases compiled only from sketches supplied by travellers. It is probable that a slight alteration in the specification of the photography may make it suitable for mapping without spoiling it for its original purpose. Thirdly, little use can be made of air photographs, and no accurate measurements made from them, until it is known where they were taken and at what scale. The determination of these details is closely allied to survey and we are best fitted to do it; sooner or later therefore we are usually asked to do so and the way in which the photographs have been taken will then make all the difference to the difficulties of locating and scaling them. Moreover, as the photographic cover of the country accumulates, we as the principal holders will be more and more in the best position to say whether existing cover is adequate or whether new photography is actually required. Thus from several points of view, although the Survey Department may not initiate photography, it should be consulted at an early stage as soon as any is planned.

PHOTOGRAPHY.

In covering a large area systematically for *any* purpose aerial photographs must be taken at regular intervals with the camera fixed in the aircraft; random photographs taken by hand are seldom of any real value. There are two types of aerial photograph: the vertical and the oblique. Of these by far the more common and useful type is the vertical, although it so happens that it is less common in the Sudan; this is the main cause of some of our special problems. But it is the basic type of aerial photography and so I shall describe it first. In vertical photography the camera points straight down when the plane is in flight, and the aircraft flies in a straight line, taking photographs at regular intervals which have been calculated beforehand so that the area on the ground covered by each photograph overlaps forward onto that covered by the next by about 60 per cent. To cover

the whole area the plane flies in a series of parallel lines so that each strip of photography overlaps sideways onto the adjacent strips by a *minimum* of 5 per cent. To achieve this for certain with visual navigation the pilot has to aim at an average lateral overlap of about 35 per cent, which means that even when he is flying at a considerable height the successive flight lines are still only a few miles apart, and that an error in navigation of only a mile or two will result in a gap in the cover. When the photography has been carried out correctly the whole area is covered by a series of photographs overlapping like the scales of a fish, and, owing to the 60 per cent forward overlap, *every* part of the area is covered by at least two photographs. Every point on the ground can therefore be viewed from some pair of successive points on one of the flight lines, and so the whole area can be viewed stereoscopically, that is to say with each of the eyes of the observer seeing a slightly different view. The trained user of air photographs seldom looks at one by itself ; he prefers to look at two together in a stereoscope (which allows each eye to see only one of the photographs) and he then sees the area common to both as a relief model in which not only the hills, but houses, trees and other features stand up and are therefore more easily identified. On a single vertical photograph an electric light pylon for example appears only as a short white line, or even as a small white dot if the photographs happens to have been taken from immediately overhead. But in two overlapping verticals viewed stereoscopically it appears for what it is—a tall white pole sticking up into the air.

Vertical photography has many advantages : the scale everywhere is approximately the same and so the quality for purposes of interpretation is uniform ; as a first approximation each photograph may be regarded as a map ; and a rough map may even be made by sticking several together to form what is called a mosaic. But, as I shall point out later on, a mosaic is definitely *not* a map ; it has its value for some purposes, but no one at all familiar with air photographs would prefer it as an alternative to the loose prints of which it was composed, for the important reason that no part of it can be viewed stereoscopically. The main disadvantages of vertical photographs, on the other hand, appear when they are being used to produce a map on a small scale, particularly if the existing maps of the area to be covered are poor. A simple calculation will show that even if the aircraft flies at a height of 20,000 feet, with a camera using a lens of 6 inch focal length, the scale of the photographs will be 1/40,000, or larger than one inch to the mile, and a single nine inch square photograph will therefore cover only a six mile square of ground. So for producing maps such as our standard

1/250,000 or quarter-inch series, vertical photography has the disadvantage of producing an unnecessarily large number of photographs on an inconveniently large scale. It has for this kind of work another great disadvantage which I shall consider later on when describing the methods of mapping from it.

In the Sudan we have several small areas which have been covered by the Royal Air Force with vertical photographs, usually taken from somewhere about 10,000 feet. Examples of these are the Khor Abu Habl and part of Zande District. We also have several large areas in the Sudd, in the form of strips along the main rivers, which were covered by a British air survey company in 1929 on behalf of the Egyptian Government. These are shown in the attached map of the Sudan.

Photographs of the other type, which are in less general use but happen to be more common in the Sudan, are known as obliques. They are taken with the camera axis inclined at a considerable angle to the vertical, usually enough to include the apparent horizon in the picture, which is then called a high oblique. Usually also they are taken at right angles to the line of flight, although they are sometimes taken through the nose of the aircraft or from under its tail. From the point of view of the user obliques have many disadvantages which are I think almost immediately obvious: scale and definition decrease rapidly into the background of the photograph, and objects are then not only far away but are viewed at a low angle so that they are often difficult to interpret; the photograph is in no sense even a rough map; it cannot be combined with others to form a mosaic; and stereoscopic viewing is more difficult than with verticals. Why then are obliques ever used? As we have seen, for producing a small scale map of unsurveyed country verticals are unsatisfactory and difficult to take; but for this purpose obliques are in many ways ideal. Not only are far fewer photographs required, which helps the user, but the flight lines can be three or four times as far apart, with a corresponding economy in flying time. Moreover navigation can be very much less accurate without causing gaps in the cover, for each oblique of a flight covers a V-shaped area stretching to the horizon, and in theory the next flight can be at any distance from the first so long as it lies somewhere in the wide area formed by these overlapping Vs. In badly mapped country, if radar aids to navigation are not available, it is very difficult indeed to take a series of parallel strips at exactly the right distance apart to maintain the correct lateral overlap of the verticals; once a gap has occurred it is even more difficult to go back and fill it—and

gaps can be caused by cloud or camera failure as well as by bad flying. In each such case the pilot cannot tell whether he has succeeded in filling the gap until he has returned to the base and the film has been developed, so that several flights may be necessary to fill in a gap once it has occurred.

So far as I know high oblique photography was used mainly before the war for producing small scale maps of areas in high latitudes, such for example as in Greenland, Spitsbergen, Canada and the Antarctic, where the existing maps were either non-existent or extremely rough. In the Sudan we have no photography purely of this type. With the war and the development of world-wide air routes came the urgent need for more accurate maps on small scales of vast areas which were in themselves of little economic value, but over which valuable aircraft would be flying in large numbers and requiring a reasonable form of map for navigation purposes. The bold, and in that way typically American, answer to this problem was to cover these areas with aerial photography and compile the new maps directly from it, using approximate methods suitable to their small scale and capable of application by large numbers of operators who would not require highly specialized training. As we have seen, some form of oblique photography was clearly indicated both from the compiler's and the flier's point of view. Thus there developed trimetrogon photography, in some ways the perfect answer to this problem ; and millions of square miles have been covered by this type of photography since its invention. A modern survey camera can cover an angle of over 70° and therefore three such cameras between them can cover well over the 180° between the two horizons on either side of the aircraft. The three cameras of the trimetrogon installation are all the same, using a 6 inch lens and taking 9 inch film ; and they are fixed in the aircraft with one pointing straight down and the other two out sideways with their axes at right angles to the line of flight and depressed 30° below the horizontal. The angles between the camera axes are thus 60°, which means that each oblique includes the horizon and also overlaps about 10 per cent onto the vertical. Between them the three photographs cover an area on the ground shaped like an hour-glass, with its axis at right angles to the line of flight, and stretching from horizon to horizon—or when the plane is flying at 20,000 feet, for well over a hundred miles on either side of the flight line. The three photographs of each set are exposed simultaneously, and so from the same point in space, and the exposure interval is arranged so that on the verticals the normal 60% forward overlap is maintained. The flight lines are spaced so that only about the lower two thirds of each

oblique are used, the photo scale at the furthest point used in each being about 1/150,000 and the flight lines about 15 or 20 miles apart. At this height, using a vertical camera alone, the flight lines would have to be not more than four miles apart to secure complete cover, so there is obviously a very great economy in flying time.

This is the type of photography of which we have some 60,000 individual prints in this country, covering two thirds of the Sudan and forming the vast majority of our photographic cover at present available, and probably also for many years to come. For its main purpose of producing small scale maps quickly it is ideal; for most other purposes far from ideal; but for good or ill it is our main photographic asset, and I shall therefore devote a fair amount of space later on to describing its advantages and disadvantages, and also our methods of dealing with it.

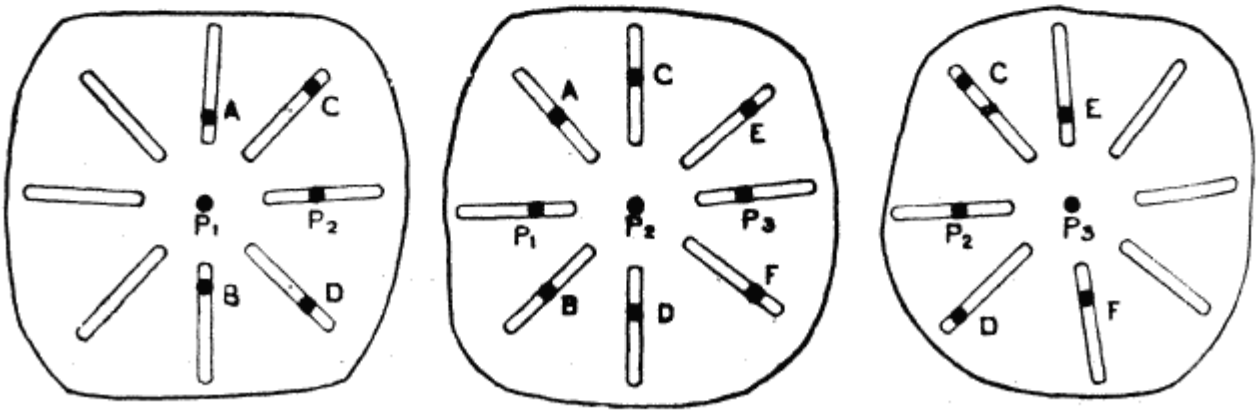
In addition to these main trimetrogon photographs the Americans also took " close-ups " of some two hundred fixed points—mostly the summits of jebels which had been fixed by triangulation—of which we supplied the correct positions so that maps could be compiled from the main photographs in the way I shall shortly describe. These "close-ups" are not in general of much value for any other purpose, but we have been able to turn out two sketch plans of towns in Kordofan from them when no other surveys were available or could be carried out in time to be of value. Not only did we supply the Americans with the coordinates of these points, and in many cases mark their exact positions on the photographs, but three of our British staff at one time or another accompanied the American aircraft which took the photographs, in order to help them identify the points. Thus began a close liaison with the American survey services which has borne fruit in the shape of these thousands of photographs and also of actual map material which I shall describe.

There are several points in connection with the taking of photographs, such as the type of camera required and the methods of navigation used, about which I shall say more below. Though they belong properly to this section of the paper their significance cannot be appreciated without some understanding of the methods employed in locating and plotting from the photographs. I shall therefore describe these next and return to the more refined details of photography when considering what new air survey we require in the Sudan and in what ways it can best be carried out.

MAPPING FROM VERTICAL PHOTOGRAPHS.

The first essential in doing any serious work from air photos is to locate them correctly. This is best catered for by taking several overlapping photographs with a constant camera setting in the way already described. They can then be linked together in their correct relationship to one another, and the whole series tied down to two or more ground points whose positions are known and which can be identified in the photographs. A single photograph covers such a small area that it will be unlikely to include at the best more than one such point, and its scale and orientation cannot be fixed unless there are two. If it is taken by hand, and therefore at some unknown angle to the vertical, at least three points are required, and moreover their heights must be known as well as their positions. It is for this reason that single photographs, as already mentioned, are usually of little value if any accurate measurements are required.

There are several methods of linking vertical photographs together so as to preserve their true relationship, but almost all depend on the *radial line principle*, which I must therefore briefly describe. It may be assumed for all practical purposes that the angles between rays drawn from the centre of a vertical photograph (strictly speaking the principal point) to any other points, even if they are on the edges of the photograph, are equal to the corresponding angles on the ground. This holds good even if the photograph is not quite a true vertical, and over ground with a considerable variation in height. But in such circumstances the area near the centre or principal point is the *only* part of the photograph where these true angles can be drawn. In general therefore an air photograph should never be assumed to be an accurate map of the ground, and from this may be seen the dangers of treating mosaics as if they



Three Slotted Templates shown separated; when they are assembled the studs which link them together will occupy the positions on each shown bythe dots.

were maps. There is another source of error in mosaics also which may have more serious results. When successive photographs are linked together by system depending on the radial line assumption, any change in photo scale due to a change in the height of the aircraft above the ground will be eliminated and not reproduced in the resulting map; but in a mosaic this is not so. Suppose that an aircraft were flying over fairly level ground but climbing steadily as it flew; the change of scale between successive photographs would not be great and they might fit together quite well at their edges. But the scale of the resulting mosaic would vary quite considerably between the two ends of the strip and its mean scale would not hold good all over it.

The radial line principle can be applied in various ways, but the most practical modern method is to replace the photographs by templates made of thin cardboard, or preferably of some stiff transparent material such as celluloid or acetate sheeting. Each template is a square and the centre of the photograph is represented by a hole at its centre; the rays from the centre of the photograph are represented on the template by slots of constant width which radiate from this centre hole. If the same point is shown on three successive photographs, on each of them a ray can be drawn through it from their respective centres. When the photographs are replaced by templates with slots corresponding to these rays, this point may be represented by a stud which fits each of the slots and can slide along them. Thus the relationships of the successive photographs to each other and to this point are represented correctly by a mechanical linkage. When a whole series of such points common to three successive photographs all the way along both sides of the strip is replaced by studs sliding in similar slots in the templates, these are automatically compelled to take up their correct relationship to each other, and the studs will also occupy their correct relative positions in the assembly. The *shape* of the assembly is therefore fixed, but its scale can be changed by moving the templates further apart or closer together, like a concertina; and its orientation can obviously be changed simply by swinging the whole assembly round one point. If therefore we have a preliminary draft of the map on which a grid or graticule has been plotted, together with all the known and identified ground control points (each of which will be represented by a stud in the template assembly), we can adjust the scale and orientation of the assembly so that these studs will fit exactly over the positions of the ground control points. All the other studs, including those at the centres of the templates, will then automatically take up their correct positions, and the points of detail which

they represent will therefore be correctly located on the map. Through the middle of each stud there is a fine hole, and when this final lay down of the templates is complete pins are driven through these holes, so that the position of each stud is marked by a pin-prick on the surface of the map. The templates are then taken up and each of these pin-pricks is ringed and numbered, and these represent the accepted positions of what are called the minor control points. It is then a comparatively simple matter to transfer the detail from the individual photographs to the map by sketching it in round these points, using some form of projector which enables an image of the photograph to be superimposed on the map at the correct scale. So long as the photographs are nearly true verticals and the ground is comparatively flat (as it is over most of the Sudan) this method will produce quite accurate results; a good detailed planimetric map can be compiled with only a small number of ground control points, but no contours can be shown and the relief can be shown only by form lines.

CONTOURING.

To produce an accurately contoured map from air photographs is a very much more complicated and difficult operation, and we have not begun yet to tackle this problem in the Sudan. I propose therefore to outline only the basic principles of how it is done. The essentials for contouring are that the photographs should have been taken with sufficient overlap so that every part of the ground appears in at least two of them; and they must have been taken with a proper survey camera—that is to say the exact relationship of the photograph to the lens must be known, and the shutter must be of a type which achieves simultaneous and almost instantaneous exposure of the whole photograph, so that it may be assumed to have been taken from one point in space. Contouring requires a much higher degree of accuracy in measurements made on the photographs than does simple planimetry, and allowance has to made for such factors as changes of size and shape of the film or prints after exposure. Neglect of these precautions will introduce comparatively large errors into the results.

If two successive photographs of a strip are put into a stereoscope so that each is seen by only one eye, the observer is then in the position of a giant who is viewing the ground with each eye at the point occupied by the aircraft when each of the photographs was taken. It is not generally realised that a pair of air photographs viewed stereoscopically gives a very much *better* appreciation of the topography than is

obtained by flying over it, but this is so. When you are in an aeroplane at (say) 10,000 feet above the ground, the amount of " squint " required to focus both eyes on the same point on the ground is clearly negligible ; and it is the unconscious measurement of this squint which gives perception of stereoscopic depth, and allows one to estimate the distance an object is away, and so to see the ups and downs in an undulating or hilly surface. These are scarcely perceptible from an aeroplane unless they are considerable. But when looking at two air photographs of the same area taken from 10,000 feet at stations perhaps 1,000 feet apart you are apparently looking at a relief model which appears to be only ten times as far away as the distance between your eyes ; and obviously the amount of squint—and therefore any variations in it—required to focus both eyes on the same spot are easily appreciable.

In country of reasonable relief, given enough control points whose heights and positions are known, it is obviously not very difficult to draw in form lines by eye from this stereoscopic relief model. The difficulty comes when one tries to turn these into accurate contours. Modern methods of photogrammetry (mapping from photographs) can achieve this and can even produce contours from several successive photographs with only a few control points at each end of the strip, which means that the distribution of such points can be very much less dense, with a corresponding economy in the ground survey. By means of accurate and expensive instruments the photographs are set in replicas of the original camera in the exact angular relationship to each other that they occupied when they were exposed. When this is done they are viewed in pairs through a stereoscope and an accurate relief model of the ground is seen. In the field of view there is also a " floating mark " in the form of a cross or bright spot which can apparently be made to move up and down as well as sideways in any direction over the model. Thus it can be made actually to touch the model anywhere, and so to follow a feature such as a road or stream bed even if this has a considerable slope. As the mark follows the feature a pencil at the other end of the machine draws a horizontal projection— in other words a map—of it. The machine can also be set so that the mark can only move horizontally ; in this case as it appears to move along the surface of the model the pencil will draw a contour.

In one form of instrument the photographs are actually viewed through lenses which represent the lens of the camera at the two moments of exposure, and the link between the apparent movements of the floating mark and the drawing pencil is mechanical. This is the

more precise form of instrument which is favoured on the continent of Europe. In another form, known generally as the Multiplex, the photographs are printed on glass and then projected onto the plotting table in complementary colours. The operator wears spectacles with similarly coloured lenses so that each eye sees only one of the photographs, and he then sees a relief model of the ground covered by their common overlap. This type of plotting machine is less precise but would perhaps be better suited to this country because there are practically no moving parts—an important consideration in a dusty atmosphere when the fitting of the mechanical links must be very accurate indeed.

In my opinion it will be many years before the heavy capital cost of either of these types of machine would be justified by the amount of work that we in the Sudan could give them to do. They are ideal for contouring areas of marked relief with plenty of visible detail, such for example as dam sites for hydro-electric schemes in rocky country. But most of our accurately contoured maps are required in very flat areas with little detail, suitable for irrigation schemes. We frequently have to show contours at half metre intervals and these areas are usually near the river and so relatively accessible for ground surveyors. We have no details, except the focal lengths, of the individual cameras used by the Americans, and it seems that no records of their calibrations were kept, so that we cannot use their photographs for accurate contouring. Fresh photography would therefore be required in any case where the circumstances of the case made ground survey uneconomic, and it would then probably be cheaper in the long run to hand the whole photogrammetric part of the job over to a commercial firm and confine ourselves to the establishment of such ground control as was required.

MAPPING FROM TRIMETROGON PHOTOGRAPHS.

The methods of plotting which I have described so far apply almost entirely to verticals ; as would be expected, obliques cannot be used to produce such accurate results, and in general the approach to them is different. It is clear that an oblique photograph gives a very distorted picture of the ground. On a vertical, for example, a tennis court will appear as a rectangle ; but on an oblique it will be a far from rectangular figure. In working from obliques the first essential therefore is to *rectify* them or, so to speak, lay them out flat so that these distorted shapes are projected correctly onto the plotting table and we can then draw them in their correct places and shapes on the map. I will not

go into details of how this is done, but it should be clear from the way in which trimetrogon photographs are taken, with two obliques showing the horizon, pointing in opposite directions, and with a common overlapping vertical, should make it possible to extend the radial line property of the vertical photograph in some way or other. In fact a series of rays covering features visible in all three photographs can be drawn from a single point at which the angles between the rays are very nearly correct. This point is either the centre of the vertical or else the point immediately underneath the plane when the three photos were taken, which is known as the *plumb point*. Clearly the images of these two points will be very close together on the vertical photograph, and when this is an absolutely true vertical they will coincide. The plumb point is the better one to use in theory, but less easy in practice, since we first have to find out where it is on the vertical photograph. This involves estimating the tilt or divergence of the vertical camera axis from the true vertical—a difficult job even with plenty of ground control, but far more so over unmapped country. On the other hand, the centre (or strictly speaking the principal point) of the vertical though less accurate is immediately found by joining up the special marks provided at the sides of the photograph for that very purpose. So long as tilts are within a few degrees the errors caused by using this easily located point instead of the theroretically correct plumb point do not seem to be large.

In very much the same way as I have already described with verticals alone a set of templates is constructed with slots radiating from whichever of these two alternative points is used. The links between the adjacent strips are formed of points which appear in the backgrounds of the obliques. If two adjacent strips run east and west a common point will be visible in the north-facing obliques of the southern strip and also in the south-facing obliques of the northern one. But these common, or tie points as they are called, have to be identified in pictures taken from diametrically opposite points of view, and this is not always an easy matter. In particular, in the grassy plains of the middle Sudan, where the patterns of the grass-burning provide almost the only points of detail recognisable on different photographs, a few days' interval between the taking of two adjacent strips may result in two entirely different patterns being shown on each, although it is usually just possible to distinguish the earlier one underneath the later.

In addition to these tie points a number of points in the foreground of the obliques are also intersected by rays though not represented by studs, and these, together with the ordinary points derived as already

described from the verticals, give a complete network of control points all over the map round which the detail can be sketched. We have a special instrument called an oblique sketchmaster in which by an arrangement of mirrors an oblique photograph can be seen apparently laid out in its correct perspective over the map, and so fitted onto the positions of any points which appear in it. Tracing of detail is then very much easier than if it had to be done entirely by eye. We work at a scale of 1/100,000, which means a two and a half times reduction from the verticals and from the foregrounds of the obliques; and it will be clear that in the areas covered by them the map can be very detailed. But as we work outwards on the obliques the detail becomes harder to see and the map therefore becomes less and less detailed, until round the tie points we are working right into the background of the photographs whichever set of obliques we use. Thus the map tends to have a striped appearance, with bands of detailed and accurate mapping separated by wider areas of less accurate and less detailed work. This is inevitable so long as we are trying to work on too large a scale, or in other words trying to extract more information from the photographs than they were designed to give. They were designed for the rapid production of maps on scales never larger than 1/250,000 or four miles to the inch. On this scale the amount of detail that can be shown is about the same as can be plotted from the most distant parts of the obliques that have to be used. It would of course be perfectly feasible for us also to produce maps of uniform texture on this scale, but only by sacrificing detail in the areas where we can actually show it, and this seems an unnecessarily wasteful procedure.

In order to indicate to the map user the areas in which the detail is more reliable, and also to enable him to add more detail from the photographs if he desires to do so, we are showing on these maps the positions of all the centres of the verticals, each being indicated by a small circle and the number of the corresponding photograph, the number being written on the map the same way up as it is on the photograph when this is correctly oriented. When the photographs are used for purposes other than mapping, whether in conjunction with such a map or not, the same difference will occur between the amount of information that they will give in the areas covered by the verticals and those covered only by the distant parts of the obliques. So long as the feature concerned is covered by verticals it can be inspected fairly thoroughly with the aid of a magnifying stereoscope; but outside these areas only the major features of the topography can be seen.

It is not possible to draw true and detailed contours from trimetrogon

photographs, but they can be used to establish a number of detail points whose heights are known to about the nearest 50 metres, and round these form lines at not much less than hundred metre intervals can be drawn by inspecting pairs of photographs stereoscopically. We have not started yet to do this, partly because we wished first to establish firmly our methods of drawing planimetric maps, and also because working in this way requires the use of a special instrument called a photo-alidade which we have not so far been able to obtain. This instrument enables the draughtsman to draw rays to individual points on a single photograph and to measure vertical angles to them just as if he were sitting on a mountain top with a plane table looking through a small window which is represented by the photograph. Very few of these instruments are made and they do not appear to be obtainable commercially; we are now investigating the possibility of making one up from the parts of old instruments in our possession, with the help of the Science and Engineering Schools of Gordon Memorial College.

THE AMERICAN COMPILATIONS.

By means of these methods maps covering several hundred thousand square miles of the Sudan have already been produced in America. They were published only on small scales such as 1/500,000 or 1/1,000,000 (16 miles to the inch), but we have been able to obtain copies of the original compilations on 1/80,000 or 1/100,000 scale which were an unavoidable stage in the reduction of the photographs to the small scales of the final maps. Since these compilations were never intended by the Americans to be used at their original scale they show only the rough outlines of the main topographical features. But owing to the huge size of the areas which the Americans compiled in single blocks, they found it necessary to locate the positions of the photographs with the greatest possible accuracy, otherwise their slotted template assemblies would not work properly, and so the relative locations of the photographs on these compilations are as accurate as we could wish. Carrying the work up to this stage takes at least half the time required to map a given area right from the start, and from this the great value of these compilations can be appreciated. There are, however, certain technical problems yet to be solved before we can add to them all the detail which can be seen in the photographs, and which we should like to show; and so far therefore they have been used only for quick revision of small areas on individual 1/250,000 sheets on which an improved map was required urgently for a specific purpose. Our main energies have been directed instead towards the complete compilation from the start

of areas which have not been mapped by the Americans and which, so far as we know, they have no immediate intention of mapping. These, and the areas covered by the American compilations, are shown in the attached map of the Sudan. The methods which we use for locating the photographs differ in some respects from those used by the Americans, and it would be of interest to make a comparison between them, particularly if this could be done in an area already covered by accurate ground surveys, such for instance as the Gezira.[1]

FUTURE PHOTOGRAPHY OF THE SUDAN.

It will I hope be clear from the preceding description of the methods of air survey that there are two main essentials to be borne in mind in carrying out aerial photography suitable for all purposes. Trimetrogon photography is definitely limited in its uses, and the usual type of overlapping vertical photography is greatly to be preferred ; but for its successful execution a properly calibrated camera must be used and the aeroplane must be navigated very accurately. So far as navigation is concerned the whole position has been altered by the invention of radar ; and this is particularly true of countries such as the Sudan, where the sketchiness of the existing small scale maps in many areas makes accurate visual navigation impossible. An aeroplane equipped with radar can fly within a few hundred metres of a given line without any reference at all to the ground beneath it. Consequently the lateral overlap between adjacent strips of vertical photography can be maintained so accurately that it is no longer necessary to aim at a lateral overlap of 35% to ensure one of 5% ; a safety margin of one or two per cent is quite sufficient, with a consequent reduction in the number of flight lines required. Moreover any gap due to cloud or camera failure can be filled very easily since its location is exactly known as soon as the photographs have been developed, and the aircraft can be directed straight back there during another flight.

If this were the only way in which radar could help in aerial survey it would be important enough. But in fact it is already possible to locate an aircraft in space—though not necessarily to navigate it there—with an error in its position of only a few metres, by means of self-recording instruments whose records can be used after the flight to deduce

[1] Since this was written news has been received that the Americans are making an experimental compilation from existing photographs of the area between latitudes 12° and 14° North and longitudes 30° and 36° East. They are taking great care to get an accurate result and more detail will probably be shown than on the previous compilations described above.

exactly where the plane was at any given moment. This development has created a new epoch in surveying, particularly in small scale and exploratory work. Already it is possible to produce accurate maps on scales as large as one inch to the mile, and contoured at about fifty foot intervals, without any ground control in the area at all; the map being compiled entirely from photographs taken from an aircraft which is controlled by two radar stations a hundred or more miles away[1]. The method was developed particularly for use in the Far East during the war, and it is already being applied in the British Colonies. At present the height of the aircraft cannot be determined with comparable accuracy, but the perfection of this is only a matter of time, and this will increase the accuracy of the resulting contours. The ground surveyor's job will then be reduced to the establishment of only the widely scattered fixed points required for locating the controlling radar stations accurately, and to checking the interpretation of detail on the photographs and supplying the names of features.

Radar fixation of an aircraft depends on measuring the distance to it from two ground stations whose positions are known, by timing the double passage of a wireless wave between them and the aircraft. In one system, known as Gee-H, the main transmitter and recording apparatus are in the aircraft, in the other, known as Oboe, they are on the ground. For use in undeveloped countries the former is preferable since the ground sets are only so to speak reflectors, and are therefore comparatively simple and light, the bulky part of the apparatus being carried in the plane. Thus the plane has to be a large one but the ground sets can be put into a small lorry, and can be broken down into sections transportable by hand. They can therefore be installed in the sometimes rather inaccessible spots which the general lay-out of the job may require in order to secure good radar fixes over the area being photographed. It is theoretically possible to work out beforehand the necessary instrument readings so that the photographs can be taken in a series of straight parallel strips, and the Americans are developing a mechanical way of doing this; but the British practice at present is to fly a series of curved strips each at constant distance from one station, the other station being used only to tell the camera operator when to take each picture. Provided that the first station is far enough away the curvature of the aircraft's path is very slight, and not enough to make any banking necessary. This is important because without

[1] C. A. Hart: "Air Survey, the Modern Aspect" *Geographical Journal* CVIII 1946 pp. 179-198.

level flight the camera axis cannot be kept within one or two degrees of the vertical, which is desirable to save trouble in working from the photographs. The actual navigation during flight is carried out in this way; then selected photographs are located as accurately as possible from the instrumental records, and these are used to control a slotted template assembly of the whole area in the way already described, except that it is the centres of the photographs which are now fixed instead of ground control points visible in them.

Photography carried out in this way is obviously extremely well done, and this method of mapping on medium or small scales is particularly applicable to the Sudan. At the moment, however, all the equipment for this type of work is held by the military authorities of the United States or Great Britain, and it is very expensive to run; so it may be some years yet before it will be an economical proposition for us to have fresh photography done in this way, however desirable it may be in theory. These considerations also limit our views of what is possible in respect of the second essential I have mentioned: the use of a properly calibrated aerial camera.

Now that the government air service is a going concern there may be some hope of modifying the aircraft to take a small aerial camera, so that we may be able to take for a comparatively small cost photographs (not necessarily for survey) at short notice of such things as floods, railway wash-outs, areas of cultivation, or towns and villages which are at present too untidy to be surveyed easily on the ground. It is not practicable in our case to use a modern full-sized survey camera taking nine inch film, but there seems to be no reason why all the Dove aircraft should not be modified to take a small camera such as a Williamson F 24 in one of the two luggage compartments, where it would not occupy more space than a rather cubical suitcase. When photography was required the camera could then be put into whichever aircraft was available to do the job, and in many cases this could probably be carried out by making only a minor diversion from a routine flight. The F 24 was not designed for accurate work and unfortunately the only available survey cameras are all too large to be installed anywhere but in the main saloon of the Doves; not only would this require a prohibitively long and expensive modification to an aircraft already completed,[1] but it could only be done to one of them, which

[1] Since this was written a new modification has been designed and it may be possible to have a proper survey camera and viewing sight installed in one or two aircraft without incurring great expense.

would almost mean setting it aside purely for photographic work. The value of having our own photographic aircraft is not yet well enough established for this to be feasible.

The essentials of a survey camera are: first that the position of the lens relative to the picture should be very accurately known, secondly that it should have a wide angle of view, and thirdly that the shutter should achieve simultaneous exposure of the whole picture and in a relatively short time. This last merits a word of explanation. The American magazine *Life* published a few years ago a "problem picture" showing a man hitting a ball, which can be seen actually wrapped round his bat, whereas the shadows of the bat and ball on the ground are separated by a foot or more. In almost any picture of a racing car going fast the wheels appear to be curiously elongated and askew, although they are known to be circular. The explanation of these anomalies is that the pictures were taken with a camera fitted with a focal plane shutter. This consists of a slit in a blind lying close to the film; when the picture is exposed the slit moves rapidly across the film and so exposes all of it for the required short interval. But obviously different parts of the picture are then exposed at different times—hence the anomaly of the shadows and the relatively different positions occupied by different parts of a fast moving racing car wheel in the one picture. In a modern aircraft travelling at well over a hundred miles an hour there will be an appreciable movement of the camera during the time that the photograph is being taken through this type of shutter, which means that we can no longer assume that the picture was taken from one point in space. As we have seen this is a fundamental assumption for accurate survey work, particularly when contours are to be plotted from the photographs.

There would be no question initially of using the government aircraft for extensive surveys; they are too small to be fitted with radar and they do not have a good enough downward view for the very precise visual navigation required without it; moreover their primary function is the maintenance of a regular air service. But there seems to be no reason why they should not be used for covering small areas of the type already described, or even for running sample strips across more extensive areas of potential value such as the forests of the southern Sudan. There is no immediate need for an accurately calibrated survey camera, but if this small less accurate camera proves its value the idea of having in addition a proper survey aircraft, modified to take a precise survey camera and also to give a good downward view, might then be worth consideration.

CONCLUSION.

I have tried to make clear the basic principles of air survey and the way in which it is done, from the initial photography to the drawing of the detailed map, and to show how the various methods used apply to the Sudan. I have also tried to describe our rather peculiar position, and it may clarify this if I summarize what I have said. So far as small scale mapping is concerned the northern and middle Sudan are very well supplied with cover, and it will be several years before all the information available from this will have been included in our maps. Our greatest need is for the extension of the photography to the southern Sudan, where the more difficult terrain and thicker vegetation hamper ground survey. The photography would have to be done either by contract with a private firm or possibly by the British military authorities, who have the equipment for doing it in the most efficient way. Plotting of the resulting maps, except possibly for the contours, could be done here. On the other hand accurate large scale mapping in the Sudan does not in general seem to require the aid of air photographs. It is nearly always wanted in flat areas suitable for irrigation, where ground survey is straightforward, but where sufficiently accurate contouring from air photographs would require the most refined methods, if it were possible at all. Large scale contour surveys of more rugged areas, which are more suitable for photogrammetry, are required so seldom in the Sudan that the setting up of expensive apparatus and the training of men to use it are not justified; and these occasional jobs would be more economically carried out by a private firm experienced in such work. Nevertheless there is a a demand for photography of small areas which cannot be met by contract owing to the prohibitive cost of bringing the aircraft and staff to the country; and it would seem worth while to take advantage of the existence of a government air service and add minor aerial surveys to its other functions.

THE SUDAN'S GRAIN SUPPLY

By J. H. K. Jefferson.

(Following this paper are some comments by the Director of Agriculture in the Ministry of Agriculture, which are indicated in the text by numbers.—*Ed.*)

THE grain supply of the Sudan is a subject of interest for two reasons: firstly because of its unique pattern, secondly because of the care and management necessary if it is to continue to satisfy national demand.

In most agricultural countries town-dwellers and peasantry obtain their staple foods from areas near to their town and villages. In the northern Sudan the staple food, *dura* (*sorghum* millets), and staple oil seed, *simsim* (*sesamum*), are produced in a relatively narrow belt across the centre of the country and sent long distances to consuming areas, both rural and urban.

For instance, Port Sudan is 515 miles by rail from the nearest producing area—around Gedaref; Khartoum and Omdurman are 108 miles from the centre of the irrigated Gezira, but 250 miles from the main Fung areas. The Northern Province, which consumes much of the commercial *dura* crop each year, is 450 miles from the Fung and 520 miles from the Gedaref area. Nearly every ton of *dura* is sent many hundreds of miles to reach its consumer: this is a remarkable state of affairs in a purely agricultural country.[1]

This divorcement of producer from consumer results in the consumer neither knowing nor caring how the major industry of the country is faring. I say "major industry" in the face of the cotton industry because, after all, one cannot eat cotton and even the Sudan cotton industry could not pay for imported grain to feed the nation if its own grain-growing were to fail. It is important that the consumers, who form the wealthy and influential part of the nation, should know what is happening in the producing areas, because their sympathy and co-operation are going to be needed in a coming struggle to put the producing areas on to a sound basis.

It is the educated and intelligent classes among consumers who must play their part in bringing to fruition certain vital pilot measures of rural reorganisation recently started by the Government.

The northern Sudan's commercial grain crop is produced in a narrow belt averaging about 150 miles in width, stretching from the Butana bridge in the east to the eastern edge of the Nuba Mountains in the west.

The belt is characterised by the *kitr* bush, by heavy black clay and by uncertain rainfall.[2]

The crop varies considerably with the seasons, but a good year would see 100,000 tons marketed. This quantity would be made up by 30,000 tons from the Gedaref area, 40,000 tons from the Fung area in the Blue Nile Province, 15,000 tons from the irrigated Gezira area, 10,000 from the Manaqil area and about 5,000 from west of the White Nile.

Broadly, the *dura* crop is produced by five methods: by true *teras* cultivation, by rainland village cultivation without *teras*, by irrigation in the Gezira, by *harīg* cultivation and by *mahal* cultivation. (a) Roughly the proportions filled by these methods are:—

True *teras* cultivation	5—15%
Village cultivation	40—60%
Irrigation	10—20%
Harīg cultivation	5—20%
Mahal cultivation	0—10%

The first and the last three of these headings give no cause for worry and the last two will be explained later. The second heading gives considerable cause for worry.

Village cultivation of the commercial *dura*-growing belt, besides being indispensable to the consuming areas, is also vital to hundreds and thousands of villagers and their families, whose livelihood it is. Village pattern, tradition, system of land tenure and agricultural method are the same to-day as they were generations ago. They are suited to conditions in which, with small populations, land is ample for all purposes and new areas are always available for cultivation while the old are being rested. The old plan—or lack of plan—cannot be a basis for a grain-growing industry which will carry the burden of demands made by a nation expanding under the impact of modern organisation. Signs of a breakdown are now very evident, but before discussing them I should like to enlarge upon the inherent technical faults which make the present village system hopeless as a national production unit.

Everyone knows that in order to obtain a steady yield of crops from a piece of land, some steps must be taken to maintain its fertility. These steps may be rotation of crops, cultivation, manuring, folding with animals or leaving the land to recuperate under natural fallow. In the rain belt the last method is used, and all cultivators know how important it is to fallow their land every four or five years for about a similar period. In the old days, when land was apparently in unlimited

(a) A descriptive note on these methods will appear in Part 2 of this Volume.—*Ed.*

supply, this was done, and enough produce resulted to maintain rural areas and provide a surplus for the small towns. Things must have gone on in this way for many generations.

Since 1900 modern transport has on the one hand encouraged the growth of towns by providing swift and cheap extraction of rural produce, and on the other encouraged rural development by the reciprocal effect.

It is difficult to say how many new villages have appeared in the last fifty years, or to what extent old ones have increased in size, but anyone familiar with the rain belt knows that the growth in both directions has been very rapid. The system of land tenure in the rain belt is generally one in which the land vests in the state or is under tribal authority and an individual has cultivation rights only over the land he is actually using or can use. The cultivator cannot reserve other areas for his future agricultural operations ; he might insist on his right to an area to which he had established title by former cultivation, and maintain it under fallow, but in practice this is only done to a limited extent — probably because traditionally there was always ample fallow land available and a fallow area actually reserved was an unheard-of thing. When demand, transport, security, public health and medical services stimulated rural development, common land under bush or grass was used for settlement and cultivation ; but to begin with no special effect was felt, since most of the land was not within the orbit of existing villages. Indeed, prosperity reigned, with gross yields and transport returns increasing annually. Eventually the perimeters of the expanding circles of village cultivation began to touch, and within a few years villagers found that new areas were unavailable and they were forced to cultivate plots after they knew that they should be rested. In this period yields dropped steeply and villages became impoverished, for the black soil is very sensitive to over-cultivation ; this affects its power to retain water between showers, and crops fail through drought.[3]

The system of land tenure, aggravated by the occurrence of water supplies at single points, which discouraged villagers from living on their holdings, was the crux of the situation. It has been said that all might have been well if there had been enclosures on the English pattern, but this is an oversimplification and hardly possible in view of the lack of water and fencing.

What signs are there that anything is amiss ?

There is the appallingly low level to which annual yields per unit area have, in many areas, been reduced. Recent investigations have shown that the average yield from such land is in the region of one-eighth

of a ton per *feddan* (b); it should be around half a ton per *feddan*. In these areas village cultivation is contiguous for long distances and fallow plots are accidental rather than intentional. These things are almost unrealised outside cultivating circles, and even there their true significance goes unheeded. Declining yields are attributed to bad seasons or any cause other than the true one, or are even not accounted for at all. Nowhere does any suggestion make itself heard that planning in the past could have saved the situation. Cultivators and rural notables seem unable to take a critical view of trends developing under their own eyes or to offer constructive plans for the future. One of the greatest difficulties of any reform is that the rural populations have to be cajoled and persuaded into accepting measures for their own good, and it is sad that they never seem able to act spontaneously without governmental goading. Here is a tough and practical problem for adult educationists, for certainly those whose business it is to carry out the technical details of new settlement schemes have not time to act in this capacity in addition to their own work.

Again, the steadily rising price of grain since controls were removed is another ominous sign of the conditions in producing areas. This rise in price is attributable to several other causes and some would argue that these are wholly responsible for it. It is not so, and I firmly believe that the true cause is the steady decline in yields from the nearest producing areas. Other contributory causes may be removed by different means, but the deterioration of the land is relentlessly forcing upwards the basic minimum price.[4]

A third sign of the worsening conditions is that so low are yields that villagers are unable to make their living from their land and, as soon as cropping time is over, they have to seek supplementary employment elsewhere, in areas such as the Gezira Scheme. Driving through the areas they have left is a dismal business; the half-empty villages are occupied only by caretakers, old men, and women with families too young to work. House repairs are neglected, there is no social life, and shops and schools are absent for there is no demand for them.

In America a migrant population of 30,000 souls is regarded with apprehension, but the Gezira has a migrant population of over 100,000. Not all of these come from depressed village areas; some are Westerners working their passage to the pilgrimage, but it is an ominous sign if the proportion of non-Westerners is too high. Equally it will be bad for

(b) One feddan equals 1.038 acres or 4,200 sq. metres.

the cotton crop if remedial measures in the rainlands are successful, unless special steps are taken to maintain the labour supply.[5]

A visible sign of trouble is the extensive banking or *teras* system which extends far south of the point where it is necessary. Where rainfall, though uncertain, is adequate for general crop production each year, the soil when managed properly will absorb enough rain to grow a crop. Banks are unnecessary here, and in any case a good soil has almost no surface run-off. In areas further north, where crops cannot be grown yearly but only in years of heavy showers, banks hold up flood water and crops can be grown in the area covered by the water standing against the bank.

As explained above, if good rainland soils are over-cultivated they lose their water-retaining power, rainfall is wasted by run-off and crops die of drought. Cultivators who cannot apply the correct remedy of fallowing seek to force surface water into the soil by preventing run-off with contour banks, so these contour banks or *teras* are an accurate visible sign of soil impoverishment. At present their use has extended down through about one-third of the commercial rain-belt and more are being made annually. Often a lazy cultivator prefers to bank his land rather than take the trouble to clear new land, in spite of loss of yield. In many cases men and women too old and feeble to cope with weed growth on new land take over old abandoned plots and so prevent their regeneration. Usually a new area does not reach its maximum yield until its second or third year; in the first year the weed growth is heavy, and this is one reason why lazy men prefer to stick to old plots and avoid the work of opening new ones.[6]

There are certain reasons why the deterioration of village agriculture has been obscured from public notice. One—the alternative source of livelihood in the Gezira cotton fields—has been mentioned. Further, the development of *harīg* areas during the war and several successful seasons for this type of cultivation have temporarily offset declining yields from village lands. Price controls also have hidden normal price rises which would have shown up increasing shortages; the rapid increase in price after their removal was a strong indication that something was wrong.

Lack of consumer goods during and after the war reduced the effort put by cultivators into their crops, for there was nothing to buy with extra money; this slowed down the evil process by relieving the pressure on the land. Similarly merchants, finding profitable war contracts, were not free with loans to cultivators or with the personal agricultural ventures to which they had been accustomed in peace time.

Again, during the war the cultivating population was thinned out by men going into the army or to profitable work on army contracts. It is true that these men still ate dura, but they only required from the land enough to feed themselves whereas had they been cultivating, they would have demanded this and a saleable surplus to supply them with other necessities of life.[7]

The fact that there is still new land available for exploitation by persons from overworked areas also mitigates the loss of the land's productive power.

What areas are most affected by the process described ? Briefly, those where water supplies are easiest and therefore settlement has been most dense. The main " depressed area " is that adjacent to and south-west of the Gezira irrigated plain. It contains the centres of Wad el Haddad, Sabil, Mikashfi and many other lesser towns and villages. Banking (*teras*) is universal here and extends southwards to the large settlement of Maiwurno at the southern end of Sennar district, enclosing the whole of Sennar Town and satellite village areas to about twelve miles westward, which is the limit of the local well field.

Across on the White Nile there is an area known as the Qafa el Mahdi. This contains probably over thirty villages which are only used for cultivation in the rains, the cultivators being inhabitants of Aba Island. Here there is no lack of land ; only lack of forethought prevents planning of agricultural operations and much of the land is banked.

Gedaref district contains a great deal of worn-out land round numerous villages within a small radius of the town itself ; practically all this land is banked. Suggestions have been made by local agricultural authorities, in the Rural District Council, that villages should adopt a simple rotation for their lands, but they fell on the deaf ears of the traditionally minded members, who were in the majority, and nothing was done.

Even further south than the top third of the main dura belt evidence of over-cultivation is easy to find round almost any large village or town. Principally such examples are found near settlements based on the Blue Nile ; west of Singa, however, on the way to Jebel Dali, is a large agricultural area with ample land and even here some *teras* are made. Everywhere in fact it is evident that neither the cultivators nor their sheikhs and omdas have any inkling of a planning sense by which to assure their own future as a sound peasantry or to found a thriving grain and simsim producing industry which can play its part in the development of the rest of the country. By this attitude the rural population are condemning themselves to a future as miserable squatters

and dibblers, as soon as unplanned development has eaten up the available fallow land. One must remember—the cultivator does not —that the available fallow does not extend as far as the eye can see but only to within three miles of a water supply, and this severely limits resources.

Some would include the Manaqil area in the short summary given. This I think is not quite right as Manaqil borders on the area where rainfall does not guarantee an annual crop, and banks are justified to produce any crop with what rain there is. This certainly applies to the area round Rufa'a and the hinterland between Rufa'a and the Butana. People in this area do not expect annual crops and every cultivated plot is on a *teras*.

Let us see how the individual cultivator fares in a depressed agricultural area. Medical authorities agree that the correct ration of dura for a working man is two *rotls* (c) daily; this is the amount issued to soldiers and police. A recent survey in the Wad el Haddad vicinity showed that the average size of a man's holding was about 4.2 *feddans* and that the average yield in the 1947/8 season was about one-eighth of a ton or 275 *rotls* per *feddan*. This gives 1155 *rotls* per plot and if there is a family of four it works out at .75 *rotls* daily for each member. But even from such a small ration the cultivator countrives to sell something to get money for essential goods; indeed much of the crop is sold to merchants in advance, before harvest, to raise loans. In this particular year some 30,000 able-bodied cultivators sold 6000 tons of grain from the area; this reduced the family ration by 440 *rotls* or by .3 *rotls* per head, so that the final amount available was .45 *rotls* per head. One can understand that feeding at this level rural populations have not much initiative either to work hard or to plan operations intelligently. If the head of the family goes away to work, his share is probably left to swell that of the rest of the family, but the net result is that by purchasing his food elsewhere he acts partially as a consumer of grain instead of a producer and increases the general price level by his additional demand—which, of course, may include some *dura* in the form of *merisa* (millet beer).[8]

Supposing it were possible to fallow half the area of land now under perennial cultivation in the Wad el Haddad and Sabil areas and to bring it back under cultivation after, say, ten years, when it had become regenerated under bush and natural grasses, and then to fallow the other half—what would be the cultivators' position ? The average plot would be 2.1 *feddans* and might reasonably be expected to average half a ton

(c) One rotl equals .99 lb. or 450 grammes.

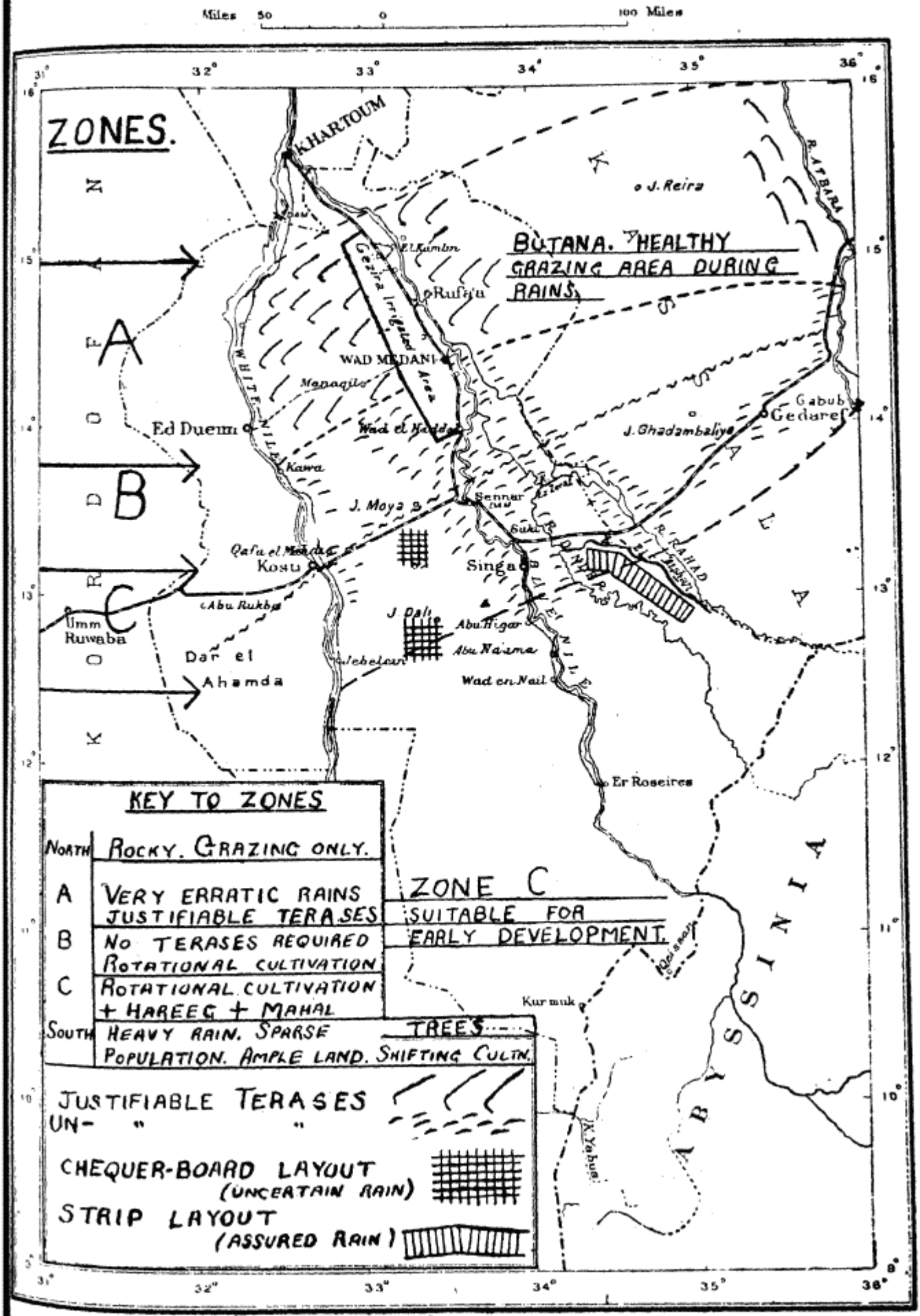
per *feddan* or 2310 *rotls* per plot. This would give the family of four 1.6 *rotls* daily basically, and 1.3 *rotls* per day if the same amount were sold outside as to-day. It is not suggested that this is a practical proposition : it would meet with overwhelming local opposition ; but it is given as an example of the difference in outlook in an area which uses its land properly and one which does not. The 1.3 *rotls* per day per head of the family is still short of the ideal ration of 2 *rotls* per day but on the other hand it is far more than the maximum which it was ever possible to issue to the civilian public in the time of controls and rationing. This was .8 *rotl* per day per head—a figure not to be forgotten, for it shows what efforts are necessary before the nation's food supply can be considered sound.

We have seen how the individual cultivator and his family are affected. Let us see how the grain market which feeds the public is being affected.

Assuming that the fertility position in the grain belt is half-way between that of new land and of land which has reached its lowest production level, the average yield over all would be 5/16 ton per *feddan*. In, for example, a year when 100,000 tons of grain come on the market, roughly 50,000 tons come from the village lands. Should all these lands deteriorate to the last degree, or to an average of 1/8 ton per *feddan*, there would be a drop of 30,000 tons in marketable *dura* by simple proportion. In fact we might lose more than this, because the proportion of grain reaching the market from land in the last stages is less than that reaching the market from land still possessing some of its original fertility. We might easily lose up to 40,000 tons, and this would reduce the ration of the town-dweller to about half a *rotl* per day ; and Heaven knows what it would do to the price !

So far the picture of the future of the Sudan's grain supply would seem black. Provided, however, that the public can be made to appreciate the problem and take a lead from Government pilot schemes, it is not black at all. Indeed it is bright ; for the Sudan, with its vast resources of land which become available with new water supplies is in an almost unique position to repair agricultural mistakes of the past. Anyone who has read that absorbing survey of world soil erosion. " The Rape of the Earth," will realise just how remarkable this position is. Communities, nations and even empires have fallen because agricultural mistakes, if realised at all, were realised too late, when remedial measures would have entailed great social upheavals which were—with one exception—impossible to face. That one exception was the Tennessee Valley episode in America.

SKETCH MAP SHOWING FEATURES OF THE SUDAN MAIN GRAIN PRODUCTION BELT



In this country the lines upon which action is being taken to remedy the situation are, at the moment, three. First come the pilot schemes for new settlements whose agriculture is planned on sound lines under governmental supervision ; secondly, control of development by private individuals ; thirdly, repair and maintenance of water supplies in old areas is given low priority in an effort to encourage migration to new areas. Some of these measures may be described in detail.

There are at present in operation three major pilot measures: the Khor el 'Atshan, the Jebel Moya and the Jebel Dali Schemes. Beside being of agricultural interest these are also most interesting from the point of view of the rural water supply engineer, for each one employs a different principle for securing its water supply.

The Khor el Atshan Scheme.—Think of an inverted Y with a long tail and with the right hand branch about three times the length of the left, in the inverted position. Place this between two parallel lines which just touch the ends of the branches of the Y, and you have a sketch of the essential natural water system from which the Khor el 'Atshan Scheme will derive its improved water supply. The left-hand parallel represents the Rahad river, the right-hand one the Dinder river, the long tail and the right-hand branch of the Y the Khor el 'Atshan itself, and the short left-hand branch the Khor Wachawish[1].

Until about ten years ago the area of the Khor el 'Atshan was practically unsettled. The reason was that mosquitoes and noxious flies made the place highly uncomfortable for man and beast for about five months of each year, and as the adjacent district was inhabited by nomad Arab tribes they did not willingly go to a place where they could not take their animals. There were two or three decrepit outposts of Arab villages but they did not prosper.

About 1938 the Khor el 'Atshan appears to have been discovered by Westerners who had got tired of the ordered life o' the Gezira and who decided to carve new homes for themselves in this place, despite discomforts. In a way they were helped by the bad conditions, for these kept the Arabs and their animals—always the foes of the cultivator —at bay. By 1944 there were about sixteen villages containing some 1600 houses, and it was at this time that the movement came to the notice of the Agriculture and Forests Department. It was soon clear that here lay a golden opportunity for starting off planned agriculture on a fair scale, with the minimum of expense and with a hard-working and co-operative people.

[1] Author's spelling.—*Ed.*

While a survey of the land and villages was in process, planning propaganda was carried on to the villagers, and in the 1946/7 winter season the land of all the villages was laid out for a three course rotation for each village, in three strips. The rotation was settled on two plots under grass or trees and one under cultivation for each village. The total area laid out was 54,000 *feddans*, which means that 18,000 *feddans* may be cultivated annually. The allowance for each cultivator was ten *feddans* and the limit to the size of the villages was set by the amount of land which could be included on a ten *feddans* per head basis if the furthest distance to which a cultivator was to go to his plot was eight kilometres. The greatest number of cultivators to be included in the original layout is 1,800. Probably however up to 2,500 will easily be accommodated as it is doubtful whether the villagers will use all the ten *feddans* allotted to them ; much of their effort will go to the adjacent *harīg* cultivation. The 1947/8 season was the first one worked by the Khor el 'Atshan villagers under the new rotational layout and it must be said that the response to the regulations made was good.

The duration of the rotations has not yet been decided upon ; observation of the progress of the first will have to decide this. Probably it will be in the region of six years since this land will stand a longer period under crop than that with lighter rainfall. Actually this area is almost out of the area of unreliable rainfall, and not far south of the northern end of the Khor el 'Atshan the *kitr* bush ceases to occur.

An interesting point in connection with the rotational arrangement is that the change from one rotation to another will not be made in a single season. The grass growth here is too heavy to allow of new cultivation being opened up directly on to any given piece of land in a given year. New cultivation is always started here by the *harīg* method and in order to enable cultivators to find a suitable piece of *harīg* in the new rotation, up to three years may have to be allowed. That is to say that any two rotations will overlap by three years, the optimum period of rotation for the old land occurring in the middle of the three. Thus if six years were decided upon as correct, the second rotation would start during the fifth year and be completely in hand by the seventh, at which time all the cultivated area in the original rotation would be abandoned. In order to ensure there being as much *harīg* as possible within the village plots, all village areas are being firelined yearly by the villagers.

Hand in hand with measures for assuring the fertility of the land in perpetuity, go measures to improve the water supply and public health of the area, although these measures are at present in a rudimentary stage.

The country between the Rahad and Dinder rivers suffers from a surfeit of water during the rains and from a drought during the summer, since wells are few and surface water is the main source. The reason for the surfeit of water is that the Rahad river overflows its banks annually, mostly to the west, and floods the country in that direction. This flood water fills many large depressions near to the Rahad itself and even reaches the Dinder river about 40 miles away. This it does mainly through the Khor Wachawish and the Khor el 'Atshan after its junction with the Wachawish. In years when the Rahad is high, about every fifth year, it overflows into the Khor el 'Atshan well south of its junction with the Wachawish, and in these years the water below the junction is about double that of ordinary years. There is one other way by which the Rahad flood can reach the Dinder, and this is through a *khor* called the Khor el Zeraf; it is about twenty miles north of the Wachawish-'Atshan junction but this only happens in very exceptional years.

If a true picture of the area is to be seen, one thing must be understood: this is that all these channels called *khors* are not *khors* in the normal accepted sense. The country here is not a flat plain but undulating in places and having what would appear to be reflections of small faults in the substrata, though I do not say that this is actually the case. The *khors* are really fortuitous junctions of depressions rather than channels carved out by water. They do not have steep banks or sandy beds and the water flows in them slowly, so that it is quite clear and silt-free. They are wide and shallow and often have large *sunt* trees growing in their beds. This type of *khor* by its nature possesses both advantages and disadvantages. An advantage, which is the *raison d'être* of present settlement in the area, is that it acts as a reservoir well into the winter and even early summer, since not being purely a channel there are many depressions along its course which do not drain with the cessation of the flood. The writer has had fresh fish out of a pool in the Khor el 'Atshan in early April and indeed these *khors* are a centre of a steady dried fish industry, the fish being caught in traps built across the connections between one depression and another at the time when the last of the flood is draining out. The bed of the Khor el Atshan varies from about 80 metres to about 200 in width.

Disadvantages of these *khors* are that having a slow stream and containing large pools they harbour bilharzia and mosquitoes and provide a great attraction for birds. These, the grain-eating weaver birds, roost in the *sunt* trees of the *khor* at night and eat cultivators' grain by day. In recent years a good deal of investigation has been done on the

problem of the grain-eating weaver bird.[d] The majority of the birds breed in the east and their line of migrations is one of the major seasonal factors affecting the country's *dura* supply. The line of migration is mainly affected by the distribution of standing water in the country over which the birds have to pass, the route with the most standing water being chosen.

Clearly the engineering problem in the Khor el 'Atshan area is the prevention or draining of surplus water on the one hand and the provision of good water supplies on the other. Happily, preliminary investigations show that these two objects can be achieved jointly. By regulating the flow from the Rahad river into the Khor Wachawish this *khor* and the Khor el 'Atshan can be used as canals to fill deep reservoirs, and as drains to escape excessive quantities of Rahad flood water if their beds are deepened in certain places. The deep reservoirs would have filter wells and settling tanks against bilharzia and would be sited along the sides of the present Khor el 'Atshan. Deepening of the Khor el 'Atshan in certain places would prevent formation of pools after the flow was cut off.

Altogether the Khor el 'Atshan is a most promising area and all it needs to develop into a sound asset to the country is careful nursing of the cultivators during its first two rotations and the necessary improvements to water supplies and public health.

The Jebel Moya Scheme.—Jebel Moya is an irregular outcrop of fine granite, roughly elliptical in shape, about 5 kilometres long and about two wide. It is about 20 miles west-south-west of Sennar, and although in an area which has about 425 mm. rainfall the hill itself almost certainly gets much more—possibly up to 500 mm., and this of much more certain degree than that of the surrounding country, due to the effect of the rocky mass upon the local climate. Such a large mass of smooth rock at once suggests catchment possibilities for rainwater, and these have been confirmed by a survey of the Jebel plinths and the *khors* flowing away from the hill. Fortunately it is very difficult for local small scale enterprise to exploit the catchment areas of the Jebel, and this has left its development almost free for the government; but, more important, it has meant that large areas of first-class soil around the hill have been unspoilt by uncontrolled agriculture.

Why it is difficult for local villagers to make use of the catchment on any scale is easy to understand. The only practical way to use run-off water is to store it in reservoirs of sufficient depth to allow for

(d) See *Sudan Notes and Records* Vol. XXVIII (1947) and Vol. XXIX (1948) Part 2.-*Ed.*

evaporation losses. This means at least six metres. Except in a few places this depth of soil only occurs some two or more kilometres away from the hill, and the villagers are not prepared to live on the black soil, preferring the granite sand at the foot of the rock. They are also not prepared to go this distance for their water and of course it is hard work digging a hole six metres deep by hand labour.

Development at Jebel Moya was favoured by its soil and water but more important is the fact that the Jebel is near to the " depressed " agricultural areas of Sabil and Wad el Haddad. A relief scheme was first thought of about 1945, but active steps, other than survey, were held up owing to lack of machinery until 1947.

The drinking water problem was solved by digging a large reservoir near one of the outlying outcrops of Jebel Moya called Jebel Fangugu. This lies about 5 kilometres to the south-west of the main *massif*. The discharge from seven *khors* running southwards from the Jebel is brought to the reservoir by two short canals. Travellers by rail to Kosti from the north may have noticed these *khors*, as they are bridged by the railway. The capacity of the reservoir is about 60,000 tons of water and this is enough for 1000 families on a generous scale, even allowing for evaporation losses.

The digging of the reservoir, which is six and a half metres deep, and about 110 x 90 metres on the surface, was done by six carryall scrapers in only 21 days.

This reservoir, or the Hafir el Eris (as it was named on its completion about the time of the Royal wedding in November 1947) is in the nature of a pilot scheme. If catchment, rainfall and other data come up to expectations, then it is estimated that Jebel Moya could support at least another four such reservoirs. This would mean that a total of 5,000 families could eventually be resettled, and this would be no small step in the solving of the " depressed area " problem. It would also place 150,000 *feddans* of first-class rainland under permanent sound agriculture.

The land to be cultivated by settlers at Jebel Fangugu will in the first place total 30,000 *feddans*, and will be used under a three-course rotation of two natural fallow to one cultivated under *dura*. Each settler will have ten *feddans* for his family ; this is more than enough for to-day's needs but the possibility of introducing machinery into the scheme has to be allowed for. The layout of the land is interesting ; it will not be in simple strips as at Khor el 'Atshan but in a chequerboard plan. The cultivated areas around Jebel Moya are definitely in an area of uncertain rainfall ; if all the year's cultivation were in one strip it is

quite possible that an unfortunate distribution of rain might fall mostly in this one strip. Therefore the cultivation has been separated into several random blocks to even out the chances.

Any rotation will be comprised of several squares in the total area. To start with, at any rate, when there will be more than enough land, cultivators will have a very generous choice as to where to concentrate their main effort for the year. It is hoped that if the whole of the Jebel Moya catchment is used and 5,000 cultivators installed and a modest average yield of half a ton of *dura* per *feddan* obtained, at least that number of extra tons of *dura* will be available for the general market after deducting the present contribution of the settlers and the *dura* used to feed the average family of four at two *rotls* per day.

This gives a glimpse of what planned agriculture can do. In order that this dream may come true the most necessary thing is a co-operative desire amongst the people for its success. To instil this desire there must be widespread knowledge of the problem being tackled; and this must come about, not through governmental pressure, but by study and discussion amongst the Sudanese intelligentsia and leading families, who are the only effective channel through which this knowledge can reach the cultivator.

Of course there are difficulties in starting such a settlement, in overcoming the traditional attitude to the land and persuading settlers to stick to rotational boundaries. The barring of the land and water-supply to outsiders and the allotment of plots are bound to cause jealousy and discontent, but given adequate staff, and the co-operation born of knowledge anticipated above, the thing should be possible—and worth while.

The Jebel Dali Scheme.—Jebel Dali is a single outcrop of mixed rocks about 800 ft. high above the surrounding plain. About two kilometres long and lying south-east and north-west, it is 45 miles south of Jebel Moya, 50 miles west of Singa and about half-way between the two Niles. Altogether it is a very solitary spot. There is a good catchment area on both sides of the razor-back of the hill; this is nothing like so extensive as at Jebel Moya, but the rainfall is greater. There are several special reasons which make a planned agricultural demonstration scheme desirable at Jebel Dali.

The surrounding land is excellent and unless a planned scheme is placed in the area soon much good land will be lost to sound agriculture through local squatting. Some demonstration of the benefits of planning is highly desirable here in the Fung for large areas of first-class land nearer the river are in imminent danger of suffering the same fate as

those at and near Wad el Haddad. Further, the future inhabitants of Jebel Dali are in the centre of a fine *harīg* area which could be extensively developed. As at Jebel Moya there is already some settlement ; it is limited for similar reasons yet it threatens a larger proportion of the surrounding land than does the settlement at Jebel Moya. At Jebel Dali the available depth of soil anywhere near the hill is small ; hence local *hafīrs* are very shallow and usually run dry by the New Year. By March all the villages are evacuated, the cultivators having returned to their permanent homes near the river. In the interval, during the *harīg* harvest season, water is brought out by lorry.

Fortunately the existing villages are not scattered round the base of the hill. They have developed only on the north-west side where catchment and storage are easiest, and the south-east is virtually free for planned development. It is hoped that by showing a successful planned agricultural community on one side of the hill, the villagers on the other side will be easily persuaded into accepting a layout for their own lands, at a later date and with the probable inducement of a good permanent water supply. There should certainly be enough water for 500 families and possibly for 1000, or—if conditions turn out to be very favourable—for 1,300. There is water storage for 80,000 tons of water, but it remains to be seen if the catchment can fill it.

The land at Jebel Dali is laid out in the same way as that at Jebel Moya, in a chequer-board plan with several squares randomized throughout the whole comprising each rotation. The rotation will probably be the same at both places — a five-year period under crop with two consecutive five-year periods under grass and bush. At least one ton of extra grain should accrue annually for the general market for each family settled, allowing for the amount they would have produced in the old way.

The catchment and storage system is interesting. Nowhere was sufficient depth of soil found for underground storage of all the water. Therefore above-ground storage had to be used, and this was obtained by using the excavated soil for high banks, so that there is about 4 metres storage below ground and $2\frac{1}{2}$ above. The reservoir was sited very near to the hill on a steep slope so that the banks of a short entrance canal soon ran out to near ground level about 250 metres away from it, thus containing the depth of water in storage. The end of the entrance canal away from the reservoir connects with two lateral canals extending some distance in either direction, whose function it is to catch water flowing from the hill in various small gullies. The reservoir itself is divided into two halves. The intention is that when, through use and evaporation, the total water has been reduced to half, the water of one

half will be pumped into the other. This will reduce the evaporating surface by half and will save up to 12,000 tons of water or sufficient for about 400 families for a year.

Controlled Village Development.—This sounds like just one more piece of governmental interference with the freedom of the individual on purely theoretical grounds. In so far as new villages were never supposed to be created without authority from someone, there is no change from past practice, but in fact control of rural development will henceforth be more carefully and strictly applied. Again there are two solid advantages, from the new villagers' point of view, in the new interest taken in their activities. Firstly they stand a fair chance of assistance for the construction of their new well, and secondly the local authorities use their influence to preserve the land allotted to a new village for that village's exclusive use and thus prevent future overcrowding by squeezing from outside.

Before a new settlement is allowed, the local Agricultural Office carefully investigates the question whether there is sufficient land available for a village, also collecting any data available on the subject of water supplies in the locality. Administrative interests are of course taken care of and proposers have to be men of approved character. The village being approved, the local Agricultural office lays out the new land on a simple three strip system. The area enclosed is usually a square, five kilometres by five, which gives an area of 5,000 *feddans*. As the villages are not intended to exceed 200 families, ten *feddans* are available for each family per year, twenty *feddans* being under bush or grass. This fits in with the simple three-course rotation of five years cropping and ten recovering. In return for these services the new village sheikh undertakes to keep to the agreed rotation and to prevent outsiders from cultivating within the village bounds.

The question has not yet been broached of some form of formal registration of new village lands, but it is probable that this will in the near future be necessary to prevent and settle the disputes which are certain to arise.

To obtain a balanced view of the country's rural economy it is helpful to consider whether we are progressing away from a state of overall soil deterioration or retreating before the factors causing it. We must ask ourselves whether the area lost annually to continuous cropping is greater or less than that put under rotational cultivation, and to what extent we are successful in recovering lands which have reached their end-point of soil exhaustion for the purpose of planned

regeneration. Until the counter-measures described were started we were losing the struggle out of hand and it is yet too early to congratulate ourselves on successes, although we have accomplished the engineering groundwork for the Jebel Moya and Jebel Dali schemes and the survey lay-outs for these and the Khor el Atshan scheme. We now have 120,000 *feddans* available for rotational agriculture in these schemes and some 18,000 *feddans* in planned village lands. This gives us a good chance of securing 138,000 *feddans* under sound agriculture in perpetuity. If we can continue to get one 30,000 *feddan*, or 1,000 family scheme going every two years, and ten new villages of 6,000 *feddans* each every year, we shall advance at the rate of 75,000 *feddans* annually. While this development is going on there should be little or no loss to unplanned development, since the staff in the field will be in close touch with areas and will easily spot any unauthorised new villages. Additionally the provision of soundly engineered new water supplies should in itself short-circuit the desire for privately constructed ones.

We can now make a guess at the time it will take us to put the whole of the important rainlands on to sound agricultural practice. The value of this guess must be qualified by the knowledge that our supporting statistics are only rough, but nevertheless we can still get an idea of the nature of the answer.

If we take the total area of the lands to be treated to be 2,000,000 *feddans* of actual cultivation, we must replace this by an included area of 6,000,000 *feddans* to give enough space for three course rotations; if in one block this would occupy an area square of side 158 kilometres. We should allow an extra 20% to allow for probable increase in population, making 7,200,000 *feddans* or a square of side about 173 kilometres. At the above rate of operation it would take 96 years to accomplish the complete agricultural revolution.

Clearly we do not want to wait for this time; about one quarter of it would seem reasonable, or 24 years, in which case we should have to quadruple our efforts, encompassing 300,000 *feddans* annually. In order to elaborate the picture I shall give the reader three further estimates: firstly an estimate of the mechanism through which I visualize this agricultural revolution might take place; secondly the probable cost; thirdly the probable economic return to the nation.

The mechanism.—I believe that the operation should be undertaken by a team divided into six sections and operating as a branch of the present Soil Conservation Board, for this is surely soil conservation. In the order of their appearance on the scene these sections would be:—

an exploratory section to locate and define potential areas for development and their water supplies; a field engineering and survey section to provide water supplies and land layouts; a propaganda section to provide intimate adult education amongst those whose lives were to be affected; a legal/political section which would arrange for any expropriation compensation and adjustment of tribal boundaries, for instance, in the probable case of a clash of interests between cultivators and nomads; a field agricultural section to supervise the early years of each component project which would be progressively withdrawn as the projects found their feet and were left in charge of the local administration; and lastly an accounts section. Each section would, of course, contain the necessary experts for its job and I would suggest that the whole should be directed by a small, active, whole-time triumvirate, covering agricultural, political and civil engineering matters. If the members of this were carefully selected for their ability to work together and see each other's problems, the whole plan would have an enhanced chance of success.

The probable cost.—Very roughly, I should put the annual requirements of the various sections thus:—the exploratory section £E. 25,000; the field agricultural section £E. 50,000; the field engineering and survey section £E. 250,000; the propaganda section £E. 20,000; the legal/political section £E. 20,000 out of which claims would be settled; the accounts section £E. 10,000 and lastly the headquarter triumvirate at £E. 10,000. These figures are intended to include all costs such as transport and leave allowances, housing etc., which are sometimes considered as a free service. The total is £E. 385,000. Over the period of 24 years estimated necessary to complete the job, the total expenditure would be £E. 9,250.000. I have not included a figure for maintenance but this, I suggest, could be recovered directly from new settlers as the operation proceeded, and I believe something around 50 P.T. annually per head of cultivating unit or family would suffice. In the case of the Jebel Moya scheme this would bring in £E. 500 yearly, and probably it would be more than enough.

I do not anticipate starting off at this level in the first year, but taking up to five years to reach it. Thereafter it would probably be possible to make up for the delay by working at a higher level, particularly if several extra-large schemes were used. A possibility here would be the "Abu Na'ama Scheme" which, briefly, is to develop a large area south of Jebel Moya by providing drinking water from fresh-water canals which would have their source at Abu Na'ama on the

Blue Nile and be filled by pump. The levelling and tentative siting of canals have already been carried out.

The return to the nation.—First of all let us think of the final effects. If we assume that the present-day situation regarding grain yields is half-way to the final deterioration of the soil, we get an average of between one-eighth and one-half of a ton per *feddan*, or 5/16 ton. We hope that in the end we shall have raised all the land to a yield of half a ton per *feddan* ; therefore if the present total yield off 2,400,000 *feddans* is 750,000 tons, at the end of the operation it will be 1,200,000 tons—an increase of 450,000 tons, worth at £E. 5 per ton £E. 2,250,000. This figure means that the annual cash expenditure of the scheme will be equalled by returns in produce many years before it is complete.

Those who care to draw a graph of the functions will see that the annual return of increased produce value exceeds annual cash expenditure in the fifth year at £E. 468,750, and that the total expenditure is actually covered by the fourteenth year, when the total excess production of new over old had reached a value of £E. 9,843,750. This does not, of course, mean that this sum has arrived back on the credit side of the ledger, but it should not be a difficult matter for inland revenue experts to collect enough cash to pay for the scheme from its products before it is complete.

Thereafter the scheme is sheer profit to the nation. One reason why results should come so quickly is that whereas expenditure is at a fixed level annually, the income, as reckoned by value of produce, increases each year by the figure of £E. 93,750 attaining to £E. 750,000 in the eighth year. In all cases I have deducted the equivalent value of produce from old land from the products of the new in calculating the profit figure.

Before we leave this aspect I should like to satisfy the very conservative and sceptical. Suppose that the average yield of properly used land does not attain a half ton per *feddan* level but only one-third of a ton ; and supposing that the yield of worn out land does not fall to one-eighth of a ton per *feddan* as I have assumed but only to one-sixth : the final position then is that the annual yield from the whole area is 733,300 tons as against 366,600 tons—an increase of 366,700 tons, worth at £E. 5 per ton £E. 1,833,500. Obviously even with these figures the scheme is still very well worth while.

It would be possible to quote almost *ad nauseam* permutations and combinations of figures covering different aspects of this subject but all would point to the same answer. I think enough has been

said to make it quite clear what is in store for this country if action is not taken. Let the reader be under no misapprehension : here is the key to the safety of the Sudan's grain supply. No amount of controls, partial or total, of reserves held and released with a view to price stabilisation or any other palliative measures, can remove the inexorable effects of wrong agricultural methods. The vast spaces of this country are deceptive, creating an illusion of illimitable resources. The fact is that these resources are almost illimitable, but only if properly farmed, and the problem should be appreciated now before delay makes the solution even more difficult. I will not readily enter into discussion over the details of my figures, for the situation can be likened to an algebraic equation ; it is the proportions which matter and I would be prepared to take issue over these.

The position of machinery in the Scheme.—In my view, the first function of machinery will be to bridge the gap between the results of the maximum effort of the cultivator operating by hand methods and the desired level of *dura* consumption for the nation. The second will be to develop an export trade in *dura*.

I do not think that the time is anywhere near in sight when all village cultivation will be mechanised. I see machinery being applied to perhaps one zone of planned villages. It will be large machinery owned and run by the government, which will perform certain fixed operations for cultivators, and the whole zone will have to be well organised with ample supervisory staff. I do not think that we shall see each village or even each cultivator owning private small machines : maintenance difficulties would prohibit this and there could never be a great enough change in the cultivator's attitude to machinery to make it practicable. However if the development of mechanised farming goes ahead faster than is expected, the new village operating with proper rotations will be in a good position to co-operate, since the land will be laid out in even blocks suitable for mechanical treatment.

A very brief mention of the difficulties besetting the use of machinery on the Sudan rainlands will not here be out of place. They all spring from a central cause ; that is, as it is impossible to clean black soil from weeds while it is carrying a crop, cleaning must be done before the crop is put in. Of course a small amount of weeding can be done while the crop is on the ground, but not much. This leads to two alternatives : either the land must be cleaned immediately before the crop is put in or it must be cleaned in previous years. Till now there has not been sufficient time to experiment fully with the latter method.

The former presents two unpleasant problems of its own. Firstly it usually appears necessary to weed the land twice before putting the crop in, and this means delaying its sowing until late August, or later, which especially in a season of short rains is cutting things very fine. Secondly, the very action of machines in the soil seems to have an effect of its own, in causing weed seeds which would have otherwise germinated in later years to come up. The problems for solution are formidable but their solution would bring great benefits to the Sudan ; there are enormous areas which could be utilized by machinery, particularly if those further south than at present contemplated are brought in.[9]

It should not be thought by those who are engaged upon the development of mechanised rainland agriculture that this aspect of the whole picture is being dismissed too lightly. On the contrary I certainly believe that the use of machinery is essential to raise the Sudan from a more or less subsistence level to what might become a considerable factor in the world's sorghum market. But this article was not primarily concerned with machinery and there are others better qualified than I to enlarge upon the subject. Whether or not we find the key to the use of machinery we must go ahead with the layout of a new rural system upon the lines mentioned, fervently hoping that while we are doing this the mechanical problem will be solved.

Let no one think that these suggestions for a remedy hold up an impossible target or offer a glittering millenium. I have tried to show what will certainly happen if action is not taken and what can certainly be done if it is. The result should put the internal grain supply on a sound footing. It will not provide a surplus or even completely attain the desired level of two *rotls* daily per head. If by the time the scheme is complete there are 5,000,000 consumers in the area under consideration, they will need 4,550 tons per day or 1,660,000 tons a year at two *rotls* per head daily, as against my estimate of 1,200,000 tons available at a half-ton per *feddan* level. There will still be a gap to fill and now it appears certain that only the use of machinery can fill ift.

NOTES ON Mr. JEFFERSON'S PAPER

By Director of Agriculture and Forests.

1. It is not a remarkable fact that *dura* is grown in the conditions most suitable for it. Rather it is a remarkable that irrigation water is still being used to produce *dura* which can be grown on rainland.

2. The potential grain belt is wider than this and may be said to stretch south to the edge of the Upper Nile swamps. The country lying between the Bahr el Arab and the Nuba Mountains may be a part of it.

3. Fallows are in fact respected over most of the area at least until a point of real pressure on the land is reached. Even then the effect of this is usually to shorten the fallow period all round without impairing the individual's right to return and reoccupy fallow.

4. I am unable to subscribe to the opinion that decline in yields of accessible areas is the main cause of price increase. The country is growing much more grain than it ever did before. It is eating much more grain than it ever did before. It has more money with which to eat more than it has ever had before. Nevertheless the conditions Mr. Jefferson describes can be found in the pressure zones of Rufa'a, Sennar, Kosti and in Eastern Kordofan, in the strip near the railway.

The evils of continuous cultivation with Sorghum *dura* have yet to be conclusively proved. *Anīs* grass is a Sorghum too, but continuous *Anīs* appears to be less harmful than continuous *dura*.

5. The movement of labour seasonably from employment to employment is an excellent feature of any country's economy and is not to be condemned here any more than in the orchards and hop gardens of Kent.

6. *Teras* as such are not evidence of soil deterioration any more than irrigation is evidence of the same. *Teras* can cause deterioration but fallowing of *teras* is a common practice in well-managed areas. It is certain that this type of banking was practised formerly over much wider areas than it is today.

7. With most of the preceding paragraphs I am in disagreement. The Gezira Cotton Scheme has increased the country's *dura*. There is no evidence over the past 50 years that the price of grain has risen at a rate faster than the fall in the value of money. The present price of grain has been reached after a long run of years of very high production. General price levels have far greater effect on grain prices than has the production level.

If the rise following removal of control proves anything, it proves that the controlled prices were out of line with other commodity prices.

8. The rain belt is divisible into a dry third where only Sorghum can be grown, a middle belt where oil seeds, especially Sesame can be added, and a wet third where American cotton and some pulses can be added to Sorghum and Sesame. The money motif is more difficult to satisfy in the dry third, which is in the main the area with which Mr. Jefferson is dealing. This population *must* seek work outside its Sorghum crop on present methods if it is to have both a diet and cash.

9. It cannot yet be said that mechanical interrow cultivation is impossible. But every effort is being made to develop a technique dispensing with it.

Conclusion.

With the general theme of Mr. Jefferson's paper the Ministry is in complete agreement.

The intensity of supervision which can be paid for by grain crops is not a high one. In the long run it must be public opinion which enforces conservative farming in these areas. For this reason also Mr. Jefferson's paper is very welcome.

SUDAN THANATOPHIDIA

By N. L. Corkill

Late of Sudan Medical Service.

The *Hemorrhous* Serpent is an *Egyptian*, of the viperine kind; of sandy and bright colour, enameled with black and white Rays on the Back; flaming Eyes, corniculated Brows, and is defended by an Armature of rough and sharp Scales; which by one is given as the Reason of making some Noise as it goes, which another denies, because it wants the *Sonalia*.

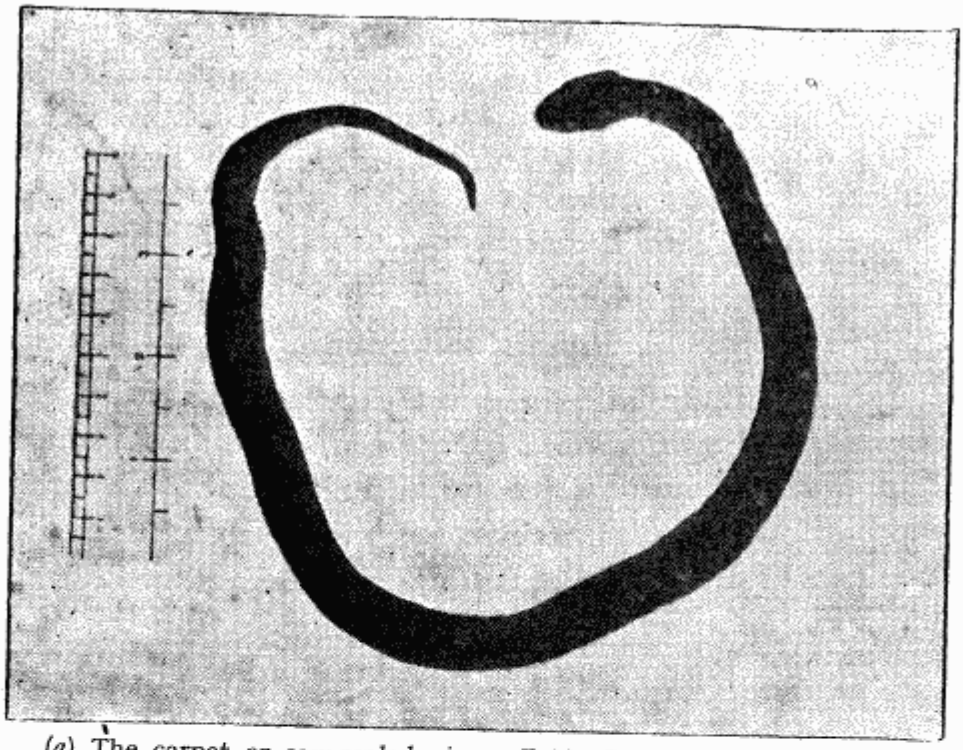
This creature is little in Body, but great and terrible in its Executions; for when it wounds any Persons, all the Blood in the Body flows out, at all the Apertures of it, which is immediately followed with Convulsions and Death.

The *Atlas* from *Ribeyro* mentions an Indian Serpent of the same malignant Nature, whose Poison operates with such Violence, that the person wounded by it bleeds at the Eyes, Nostrils, Ears, and all the Pores of the Body, and the miserable Patient is irrecoverable.

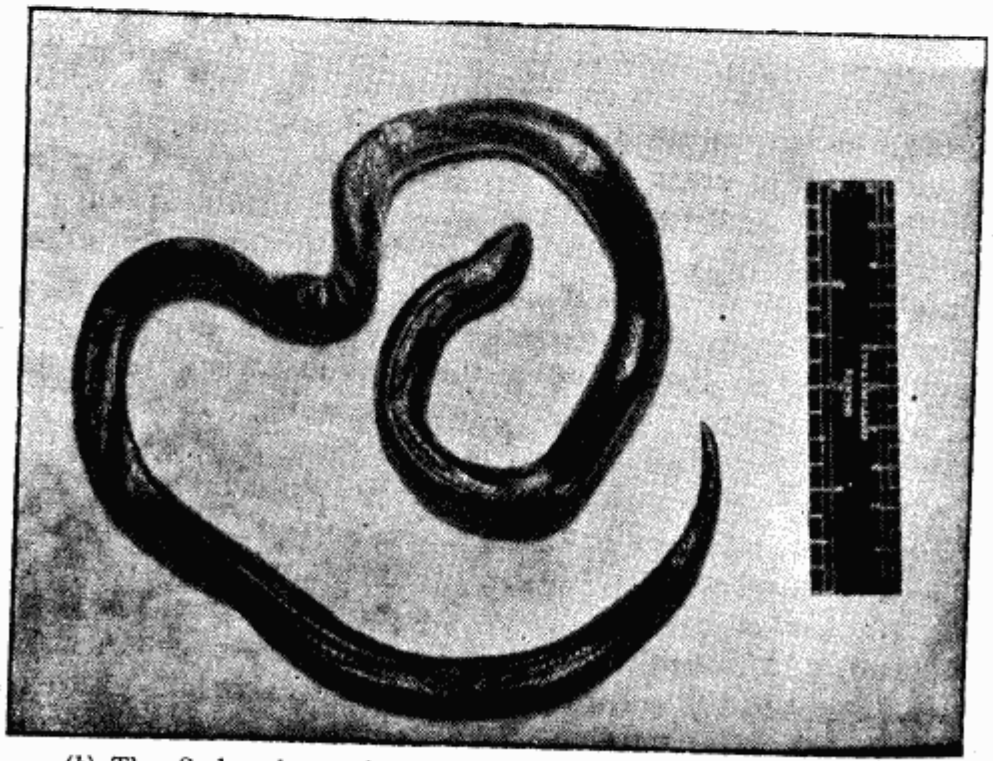
CHARLES OWEN (1742).

THE Sudan Government Report on the Antiquities Service and Museums 1946 (Arkell, 1947) states that the Sudan or black burrowing viper, *Atractaspis microlepidota* Gnthr., "is reported to be the cause of most of the deaths from snake bite on record," (*i.e.* in the Sudan). The present writer suspects this to be a little misleading. His own feeling after sixteen years service with the Sudan Medical Service and continual interest in the subjects of snakes and snake-poisoning is that north of, say, lat. 9° N.—he cannot speak with any useful experience of further south—the carpet or saw-scaled viper, *Echis carinatus* (Schn.) is responsible for most cases of snake-bite and most deaths from snake poisoning coming to the notice of the administration. Thereafter he would rank in importance the Sudan burrowing viper.

The lack of reported deaths from the three local species of cobra and their absence from administrative experience in hospitals and in the field remains a remarkable fact in the Sudan (and elsewhere in Africa). The snakes themselves, the African or Egyptian cobra *N.haje* (Linn.), the black-necked or spitting cobra *N.nigricollis* Reinh. and the black and white cobra, *N.melanoleuca* Hall., are common enough, certainly the first two. Apparently one undoubted case occurred in Cairo when—sometime in the early years of the recent war—a snake-charmer was bitten by one of his exhibits and died shortly afterwards, having first reported at a police-station with the bag containing the snake which bit



(*a*) The carpet or saw-scaled viper, *Echis Carinatus* (Schn.). From a Camp near Abu Deleiq, July 1946; bit a woman. The only non-black snake in the Sudan with undivided scales on the underside of the tail.



(*b*) The Sudan burrowing or black burrowing viper, *Atractaspis Microlepidota* Gnthr. From a net near Abu Deleiq, July 1946. The only black snake in the Sudan with undivided scales on the underside of the tail.

him. It was sent to the Giza Zoological Gardens, and identified as an African (Egyptian) cobra *N.haje*. The writer has to thank Dr. Ibrahim Abd el Magid of these Gardens for this information and for showing him the snake in 1944. It appears that one other undoubted case can be quoted also. In 1939, in Luxor, the writer talked to the son of Musa the famous local snake-charmer, who had died the previous year, and satisfied himself that the old man had died from the bite of a cobra which must necessarily have been either the African cobra or the black-necked cobra, unless an Indian cobra, *N.naja* (Linn.), had been imported, which is extremely unlikely. The son described symptoms compatible with cobra poisoning and produced a small *N.haje* (without its fangs !) as an example of the type of snake that killed his father. In the Nuba area the so-called black mamba *Dendraspis augusticeps* (Smith), is much feared and hearsay deaths have been reported. The puff adder *B.arietans* does not appear to be greatly feared, although, in the Koalib, there exists a test whereby a fatal prognosis is determined. A man bitten by this species, and obviously seriously ill, will have a handful of the hair on his head given a hearty tug. If it comes away, a fatal outlook is considered certain and all hope is given up.

The table below gives an analysis of 334 cases of snake-poisoning collected by the writer in the period 1930-1946 either from personal experience, by searching hospital records, or from details communicated by colleagues. They are mostly from Kordofan, the Kassala area, Khartoum Province, and the Fung. It will be noted that only 21 ended fatally (6%), and that in only 46, (13%), was the snake secured and definitely identified. In a number of cases, the description of the snake as being small, " red " (*sic*), spotted and as making a noise, generally described by the Nuba as like the sound " *shou*," taken together with the haemorrhagic symptoms and the known distribution of viperine species, allowed of no doubt that the carpet viper was responsible. Similarly, certain cases with haemorrhagic symptoms who stated they had been bitten by a black snake allowed of no doubt that the Sudan burrowing viper was responsible. Such cases were fairly common in Khartoum Province, the Blue Nile Province and Kordofan. The small series of cases, 26, has a fatality rate of 20%. Wall (1921) in writing of this snake in India and Ceylon states " Dr. Imlach speaking of Shikapur where *Echides* are very abundant estimated that about 20 per cent of the snake-bitten died " and again "Vidal, speaking of Ratnagiri, where the saw-scaled viper is incredibly numerous, estimated that about 20 per cent of *Echis* cases proved fatal."

TABLE

SNAKE POISONING IN THE SUDAN

ANALYSIS OF 334 CASES COLLECTED BETWEEN 1930 AND 1946 IN THE NORTHERN AND CENTRAL ANGLO-EGYPTIAN SUDAN

SNAKE	EVENT		
	Bite	Eyes "spat" in	Death
Aglyph colubrids :			
Lined house snake, *B.lineatus* (Dum. & Bibr.)	4	—	—
Opisthoglyph colubrids :			
Hissing sand snake, *P.sibilans* (Linn.)	2	—	—
Elapids :			
African cobra, *N. haje* (Linn.)	1	—	—
Viperids :			
Black-necked cobra, *N.nigricollis* Reinh.	1	2	—
Demon night adder, *C.rhombeatus* (Licht.)	3	—	—
Green night adder, *C.resimus* (Ptrs.) ..	2	—	—
Puff adder, *B.arietans* (Merr.)	2	—	—
Carpet viper, *E.carinatus* (Schn.) ..	19	—	1
Believed carpet viper	7	—	4
Sudan burrowing viper *A.microlepidota* Gnthr.	10	—	2
Believed Sudan burrowing viper ..	1	—	1
Unidentified or uncertain	278	2	13
Totals	330	4	21

It has been recorded (Corkill, 1935) that folk-opinion in the Sudan has it that the African cobra may spit as well as the black-necked cobra ; but enquiries at the Zoological Gardens in both Giza and London reveal no knowledge of *haje* spitting. None the less, this folk-opinion together with Bogert's (1943) illuminating paper describing the specialised dental mechanism in the undoubted spitting types (*Haemachatus haemachatus* Lacép.), *N.nigricollis* and *N.naja* (East Indian forms only), which

determines the direction of ejected venom, and the writer's memory of finding a cobra in a collection examined hurriedly in 1945, with the suboculars characteristic of *haje* on one side but with none on the other, raise two queries, firstly as to whether hybrids may occur and secondly as to whether those cobras of the Sudan determined as *N.haje* should not be carefully reviewed and their fangs examined, for it may be that a southerly Sudan population of *N.haje* may spit—a parallel to the spitting Malayan and East Indian group of *N.naja* as compared with this species in its more northerly non-spitting forms.

It may be appropriate to give here an up-to-date list of the thanatophidians known to occur in the Anglo-Egyptian Sudan; only one opisthoglyph is considered dangerous and therefore included in the list. The rarity *Elapechis laticinctus* Wern. was not encountered in 1833 specimens catalogued from all parts of the Sudan from 1930-1946.

Colubridae: (Opisthoglypha)

Tree snake or boomslang, *Dyspholidus typus* (Smith).

Elapidae

African or Egyptian cobra, *Naja haje* (Linn.).
Black-necked or spitting cobra, *Naja nigricollis* Reinh.
Black and white cobra, *Naja melanoleuca* Hall.
Black mamba (the name is apparently a misnomer, for grayish-green seems to be the common colour) *Dendraspis augusticeps* (Smith).
Jameson's mamba, *Dendraspis jamesoni* Wern.
Elapechis laticinctus Wern.

Viperidae

Demon night adder, *Causus rhombeatus* (Licht).
Green night adder, *Causus resimus* (Ptrs.).
Horned viper, *Cerastes cornutus* (Linn).
Carpet or saw-scaled viper, *Echis carinatus* (Schn.)
Puff adder, *Bitis arietans* (Merr.)
Gaboon viper, *Bitis gabonica* (Dum. & Bibr.)
Rhinoceros viper or river jack, *Bitis nasicornis* (Shaw).
Black burrowing or Sudan burrowing viper, *Atractaspis microlepidota* Gnthr.

The writer has not heard of a foreigner being bitten by a snake in the Sudan and only once of a Sudanese of the "official" category, in this case a doctor, who if remembered rightly, said he had been bitten by a Sudan burrowing viper and recovered with no special

treatment or difficulty. The vast majority of the bites analysed above occurred on the foot or leg in barefooted or sandalled persons at night or in the grey of dawn. Appropriate precautions are obvious: when daylight or moonlight are absent, shoes or boots, a torch and a stick are clearly indicated in snake infested areas.

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LOMORO XUJANG (1853 - 1912)
a Lotuxo Chief, Tirrangore
By Fr. Carlo Muratori, V.F.M.

ONE of the most impressive figures amongst the historical Lotuxo[1] chiefs is certainly Chief Lomoro. There is no Lotuxo boy to-day who has not heard of him during the evening conversation with their aged people.

He is son of Xujang (*alias* Amoyya, the "Moy" of Baker), who was the head of the Tirrangore chiefs, after the religious Lotuxo kingdom had split into two main divisions, viz. *Aati Xujang* (people of Xujang), whose centre is Tirrangore, and *Aati Mayya* (people of Mayya), whose religious centre is Oronyo, associated with Ilyeu.

His mother is Iloyi, whom Xujang married from the chief of Oxulla, a hill between Lirya and Lepful (shown as Lafon in the maps), just a year before Oxulla and Iguda people abandoned both places: according to Father Angelo Vinco, this was about 1847.

Lomoro entered the warrior class (*Ojetuk*) in 1873, as a member of '*alisa*,' the youngest group of the class. This as well as the fact that he is given as born under *Ojugu*, the precedent class, lead us to believe that he was born in 1853-1854, otherwise he could not have entered the *Ojetuk* class.

Being a man of strong will, quick thinking and energetic, at the time of the death of Lajaru the successor of Xujang, he succeeded in conquering the heart of Ikang, Lajaru's wife of the royal clan, which had to continue the religious work of the late husband. He inherited her, and from this, together with his personal prestige, he found it easy to make his people recognise him as chief. He succeeded Lajaru in the year 1892; and in the following year he presided at the solemn initiation of the new warrior class, which he named *Nyaxwat*. Although the religious work was officially entrusted to Ikang, he (as well as his successors) was actually performing the greater part of it.

He soon thought of enlarging his kingdom, but he had to deal with a crisis when for a period of two years there was a lack of rain, and people were complaining against him: "You don't give us the rain." For this reason he went to abide at Loguruny—a sacred place of the

[1] The authors' spelling of names has been retained in this note though it is not in accordance with official usage.—*Ed.*

Lotuxo chiefs—together with Ikang and Aceber, a wife of the royal clan from Obo, Acoli, and his mother Iloyi.

In subduing the neighbouring people, he needed to fight only twice, viz. against Lallanga village (of the Lomya subtribe) and against Logir subtribe (whose centre is Lodwara). On other occasions he cleverly used bluff to threaten people, taking them by surprise one by one.

Taking advantage of the prestige he had over his people and of the fear they had of him, when he wanted to subdue a new village or village group, or to frighten them when refusing his control, he collected the warriors from all his villages. With such an immense mass of warriors, encouraged by the presence of the chief himself, excited by the shining of their spears and helmets, and the singing of their war songs, he used to appear suddenly at a village, which of course in order to avoid the threatened destruction would submit and recognise Lomoro as their chief and rainmaker. Henceforth he had the duty of giving to the conquered village the annual rains, and people were obliged to take him their offerings when they were going to ask for rain, to cultivate his fields in each village, and to give him the traditional part of the game killed in their hunts.

In this way he succeeded in subduing not only all the true Lotuxo (except the village of Torit, where Oxide, his brother, was the chief, and a part of Loronyo), but also the Xoryok on both sides of the Xos river from Xilyeu to the Ikoto region, then the Nilo-Hamitic Lango, Dongotono and Lomya.

Another fact, which shows the readiness of Lomoro in appreciating new and unexpected situations, is that he realised at once the necessity and usefulness of subduing himself to British rule. He agreed to meet MacDonald who was coming from Uganda. Accompanied by some thousands of warriors with 20 rifles (according to the family traditions) he met MacDonald at Loguruny in 1898. He made a good impression on MacDonald who gave him two banners. The Uganda Government settled a Post at Ikoto, where Xawwo (father of the Chief Loppwanya) was chief at Lomoro's orders. Lomoro gave two smaller banners to Xawwo, which are said to be still kept by chief Loppwanya who is in very good terms and friendship with the Tirrangore chiefs. But the two banners given by MacDonald to Lomoro were burnt by the surviving wives of Lomoro, while chief Oxuyyoro, the third successor of Lomoro, was fighting against Imotong, where he died during the fight.

The authority of Lomoro was great and supported by the people, but hatred and revenge were ripening within his family, His relatives were waiting the moment to overthrow his dictatorship and tyranny.

The centre of the rebellion against Lomoro was Iloli, where an Iloli man, bribed by Lonyong, Lomoro's brother, hit the great chief with a well-thrown spear, killing him on the spot. Lomoro was buried at Loguruny. This was the year 1912, and the killer, named Lomiyuk, is still living (1947) at Burung, whither he escaped because Iloli split into two parties, a pro-Lomoro party and an anti-Lomoro party. The two parties fought inside the village and the anti-Lomoro party was defeated : most of them escaped to Burung, from where little by little they came back again to Iloli. In that year the warriors Nyaxwat were still holding the village of Tirrangore, but the new solemn initiation was to take place in the following year.

Such was the tragic end of this native dictator. With his death, his great kingdom ended : it split into four main parts, Lonik at Tirangore with Imotong and Ikoto ; Oxide at Torit ; Oxuyyoro at Logurunu ; Lonyong at Lofi. They were all brothers of the late chief, and although they were partly re-united under Oxide, Lomoro's kingdom disintegrated definitely under Oxuyyoro. To-day the kingdom includes four Lotuxo villages and Ikoto. Like the wild vine-tree, which grows along the Xos river, Lomoro's creation grew and disappeared in one season, but his name remains and will remain for long in Lotuxo traditions. It is regrettable that at Loguruny no sign reminds the passer-by of this great chief.

ELIXIR

By G. W. Bell

Sudan Political Service.

The English word Elixir, derived from Arabic, is believed to be an adoption from the Greek *xerion*, which was a powder used in the cure of wounds. The term has always been wide in meaning and applicable both to the medium that would effect the transmutation of base metals into gold, and to the substance—more strictly *Elixir Vitae*—that was believed to be capable of indefinitely prolonging life.

The belief in the existence of the Elixir is widespread throughout Arab countries and the Sudan, and particularly in the hill districts of Kassala and the Nuba mountains. Local traditions on the subject vary from place to place but in general the possession of the Elixir is believed to be difficult of achievement by reason of the extreme inaccessibility of those places in which it exists, and of its jealous guardianship by hawks and serpents.

A common belief is that the tree approximates in appearance to the vine, and indeed it is sometimes referred to as *anab*. Another theory is that the Elixir is a parasitic growth which in the manner of mistletoe attaches itself to any tree or shrub. In any event it is believed to bear small red berries, and on the leaves are to be found inscribed the words " *La 'llah illa allah.*" The berries possess the special property of bringing success to the hunter and the marksman : ground into a powder they are carried in a leather pouch, and before setting out on the chase the hunter burns a small portion and allows the smoke therefrom to penetrate the barrel of his gun.

In general the property of the Elixir is believed in the Sudan to bring success in all ventures, to have the power to turn any substance into gold, and to ensure immortality. A story from Kabushia records that when El Sayed El Hassan El Mirghani visited a boys' School there he found that the pupils were able to commit the Q'ran to memory without the least difficulty. The reason believed was that the boys regularly drank the milk of goats which grazed in Jebel Ibn 'Ali nearby, and which frequently fed on the Elixir which grew in the vicinity.

An Elixir is said to grow at Jebel Abu Shok close to Rashad on the Tegali road. Some marksmen on one occasion shot at and severed a branch from the tree, but the guardian hawks swooped down and gathered it up and carried it off before it fell to the ground. The same tale is told in the case of the Kassala and Jebel Eliri Elixirs.

Attempts to obtain the Elixir generally end in failure and often fatally. During the time of Mek Nasir Abakr of Tegali (1844-1859) a number of endeavours were made to obtain the Elixir which grew on the unscaleable heights above Tasi. Eventually the Mek himself ordered a man to be let down on an *angarīb* by ropes held from above the rocks in which the tree was seen to be growing. The *angarīb* was lowered without mishap, and after what seemed to those above a reasonable interval, drawn up again. The man was dead ; he had been killed by the snakes and hawks, guardians of the Elixir.

THE DISCOVERY OF A MEROITIC CHILD'S GRAVE IN KHARTOUM

By Thabit Hassan

Antiquities Officer.

THE site lies in Block VIII East, Khartoum, about 13 metres north of the famous Gordon defensive rampart and in between the Christian Cemetery and the Police Eastern Station.

A few scattered beads and a number of sherds of pottery which were noticed by Mr. Oliver Myers of the Gordon College lying on the surface led to the discovery of the grave. Mr. P. L. Shinnie, Assistant Commissioner for Archaeology, then asked me to excavate this burial. Aided by Osman El Hassan, the Antiquities Mason, it took me two mornings working very carefully and using small tools like a trowel and a toothbrush to complete the clearance.

The body was found at a depth of only 25 cm., probably due to the rain and wind removing the earth for centuries. It was lying on its right side with the head lying towards the south and facing east in a crouched position.

Two necklaces were found round the neck, the strings of which had perished. One of these necklaces was made of faience and rather small, which indicates that it must have been meant to be a collar. The other was much longer and made of ostrich egg-shell discs.

Round the waist there were two bead belts. One of these was composed of rounded perforated discs of ostrich egg-shells but smaller in size than those of the necklace. The other belt was composed of blue faience segmented beads. The number of segmentations varied from two to four in different beads.

Just in front of the skeleton was found a small rusty iron spear-head, much corroded and broken into four small pieces : a dark line in the sand marked where the wooden shaft had been.

From the size of the skeleton and the undeveloped bones it was evident that the body was that of a child. The skull was taken to Dr. Horgan, Assistant Director, Laboratories, in order to assess the age of the child by means of the teeth which fortunately were complete. By carefully studying some of the permanent teeth, which were just beginning to replace the milk teeth, it was concluded that the deceased was between six and seven years of age at the time of his or her death. The sex of the child still remains unknown as the bones are not developed enough to enable the sex to be determined.

It proved very difficult to date this grave owing to the scantiness of evidence, especially the pottery which is the main factor in determining dates. The egg-shell beads and the elongated blue faience ones can be dated to a number of different periods.

However, there is enough evidence to place the date of this burial in the Late Meroitic Period *i.e.* 50 B.C. to 300 A.D. This was arrived at by examining the rest of the finds. The iron spear-head is a good proof that the grave was Meroitic as iron was abundant in the Sudan during that period, in addition to the fact that the only similar iron spear-heads in the Khartoum Museum were found in the late Meroitic graves which Mr. A. J. Arkell excavated in the Khartoum Civil Hospital site.

The kind of segmented heads which were found round the waist of the child is very rare and the only ones which have been previously found in the Sudan and can be compared to them, were produced from the same Meroitic burials. Moreover the small fragment of pottery which was found at the top of the grave emphasises this conclusion. It is a small flat rim, burnished black and decorated by dots from the inside. This kind of pottery is only known so far from the Meroitic Period.

Therefore, in view of the above evidence, I think it is safe to say that the burial in question was Late Meroitic and that it forms part of the same cemetery as that discovered on the Civil Hospital site.

MARABOUT NESTING COLONIES OF THE SOUTHERN SUDAN

By A. B. Anderson

Late Assistant Game Warden.

In Equatoria Province all colonies found have been cliff colonies and are small. This is probably due to two factors: the first is that the number of nesting ledges is limited; the cliff faces are sheer and a nest toppled over might fall two thousand feet, and presumably any ledges that form soon slip down themselves. (These big granite hills seem to peel like onions). The second factor is food supply: fish form the staple diet of the marabouts in the southern Sudan and these isolated hills are by their very nature often far from suitable swampy fishing areas. Number one colony at Liria on the main Juba-Torit road is 30 miles from a fish pool. In any case the breeding season, September to the end of December, is high-water time and unsuitable for fishing. The adults do not seem to leave their nest in search of food: they either sun themselves on the ledges or interminably (and apparently aimlessly) soar round and near the rock faces. The young leave the nests at the best fishing season.

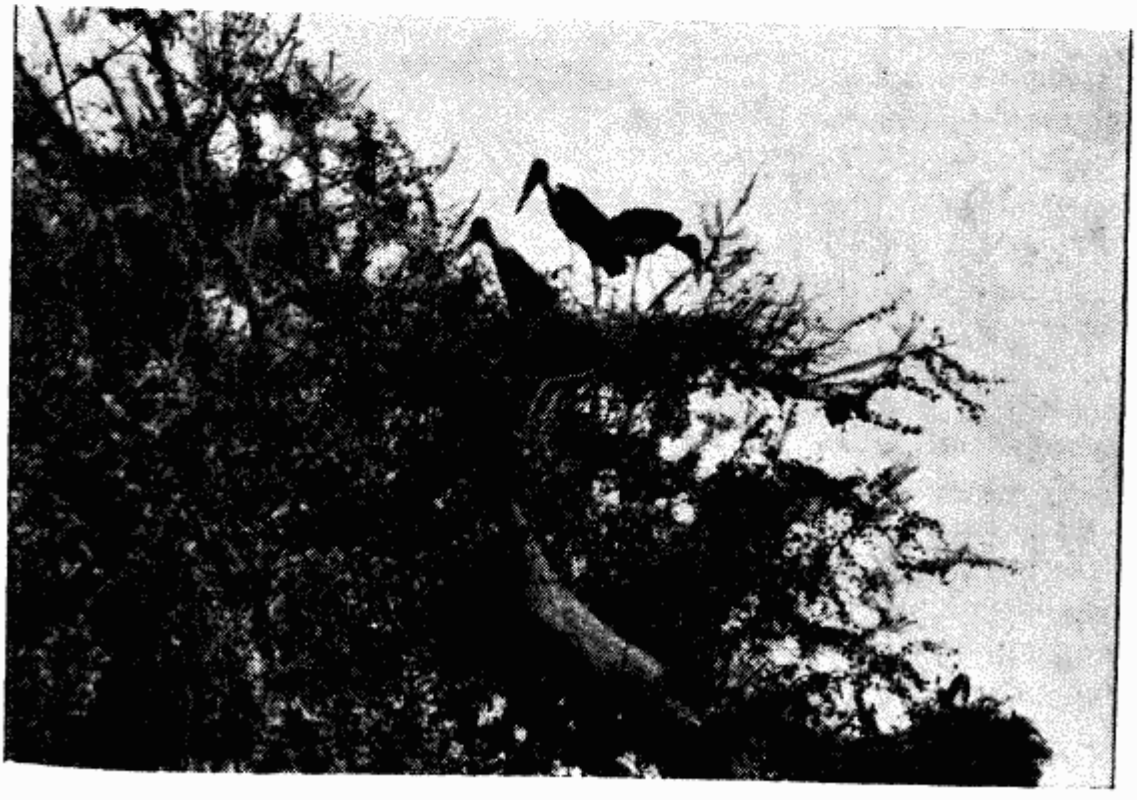
The following colonies exist in Equatoria Province. Those marked * have been reported to, but not verified by, the writer :—

1. Liria .....(Lat. 4° 40′, Long. 32° 05′). 40-50 birds. 1-9-46. Fine rock face.
2. Murukurren .....(Lat. 4° 17′, Long. 33° 10′). 40-50 birds. 17-9-46.
3. J. Chalamni .....(Lat. 4° 30′, Long. 32° 54′). Unoccupied 1945 and early 1946: 12 birds 7-11-46. A poor broken rock face where predatory animals could get at the nests. Presumably an overflow colony from No. 2.

* 4. J. Logotok .....(Lat. 4° 39′, Long. 32° 50′). Reported similar to No. 3.

5. J. Odo .....(Lat. 5° 15′, Long. 30° 30′). This cliff is so high that the nests can scarcely be distinguished with ×6 binoculars. 62 birds on wing 24-9-46.
6. J. Lokolo .....(Lat. 4° 38′, Long. 31° 57′). 25 birds perched 7-10-46.





7. J. KALOKO .....(Lat. 4° 20′, Long. 31° 05′). About 6 nests 24-1-47.
8. N.W. OF NIMULE ....(Lat. 3° 37′, Long. 31° 57′). Small colony.
9. J. MBELI .....(Lat. 3° 34′, Long. 31° 50′). This is near Laropi in Uganda but is included on the chance that it may not have been recorded. Small.

* 10. J. NYERI .....(Lat. 3° 45′, Long. 31° 50′).
* 11. J. TIMU .....(Lat. 3° 52′, Long. 31° 40′).
* 12. J. REJU .....(Lat. 3° 54′, Long. 31° 42′).
* 13. J. DONGO .....(Lat. 3° 55′, Long. 31° 40′).
* 14. J. LIRIAMO.....(Lat. 3° 53′, Long. 31° 45′). The last five colonies are probably small.

In the flat swampy Bahr el Ghazal Province I personally have only seen one colony—Number 3 below. The other two were reported to me by the District Commissioner, Mr. E. H. Nightingale.

* 1. ATET REST HOUSE. (Lat. 6° 32′, Long. 30° 05′). In *doleib* palms.

* 2. (Lat. 6° 45′, Long. 29° 45′). Nest with wood ibis *ibis ibis* on fig trees, thorn trees etc. A fairly large colony but numbers not available.

3. TOURALAI. (Lat. 9° 36′, Long. 28° 24′). About 10 nests in a tree with wood ibis 1-3-47. It is not known whether this late nesting is normal: 1947 was a very late year, and the motor track to Kordofan Province was still under water, which is unusual for March. It is however interesting to compare this date with those given for Upper Nile Province colonies.

Again in the Upper Nile Province I have personally only recorded the Ler colony and information has been most kindly supplied by the District Commissioners of the different districts. The information given in their letters is so interesting that I have preferred to quote them rather than tabulate.

Ler in Western Nuer District is at Lat, 8° 15″ Long. 30° 10′ where it was estimated that there were between 200 and 300 trees with from three to six nests each. These trees are often quite low so that one was able to walk up and photograph the birds on their nest with an ordinary hand camera. Mr. D. K. L. Rae, the Assistant District Commissioner, states that the birds nest in the following trees: Heglig (*balanites aegyptica*), African Elm (*celtis integrafolia*), Gameiza (*ficus sycomorus*) and the Sausage Tree (*kigelia aethiopica*), and he adds " the lime of the birds eventually destroys the tree and you will have observed a number

of African Elm trees round Ler destroyed by the storks. The time programme in this colony is as follows :—

Nests built .....end November.
Young hatched .....Christmas.
Young can fly .....early March.
Colony abandoned .....end March.

When I visited Lake Nyubor (Lat 6° 53′ Long 30° 15′) in April this year there were large numbers of Marabout around the lake. I wonder if some of these had migrated from Ler."

There is no information of any breeding colonies round Lake Nyubor or elsewhere in Western Nuer.

Capt. G. S. Renny, District Commissioner, Eastern Nuer District, writes as follows : " The only nesting site I have observed is J. Shotina (Lat. 9° 03′ Long 34° 06′). Shotina....is a rock pinnacle, standing like a phallic symbol, several hundred feet high, in the northern foothills of J. Gemi, the most westerly buttress of the Abyssinian plateau in these parts. The storks nest on ledges on the topmost half. On several occasions I have sat underneath and watched them through my glasses. I cannot give an exact estimate of the number of nests, but should say up to 50 on the eastern face. I last saw them there in January 1948. I suspect there may be another nesting site on J. Teibo a few miles west of Shotina. I noticed white streaks as of bird droppings, on the rock face."

Finally Mr. R. E. Lyth has this to say about Pibor District : " There is one at N.Lat. 6° 48′ E.Long. 33° 44′. There is a large *heglig* forest here and each tree has two or three nests in it. I find it difficult to estimate the number of trees there are, but I should think upwards of a thousand. I have passed through this area during each of the last three dry seasons in late February or March. Each time I have seen young birds in the nests, but none flying or on the ground. I am told there is a very large colony in a *heglig* forest in the uninhabited area south of Pibor Post (about N. Lat. 6° 38′. E. Long. 33° 7′), but I have not yet seen this. It is said to be much larger than the above.

" I remember also seeing a colony in one of the hill forests at Boma (Lat. 6° Long. 34° 30′), I think S.E. of the Fort. The birds were building in some of the very tall trees that there are at Boma. My impression is that this was not a very large colony—probably not more than 300 nests. Some Marabout also nest every year in a tall pinnacle of rock (Ngacitiligwan) a mile or so south of the fort at Boma."

Mr. Lyth also states that colonies are reported at Lat. 7° 42′ Long. 33° 26′, Lat. 6° 34′, Long. 33° 26′, Lat. 6° 18′, Long. 33° 15′,

Lat. 7° 20′, Long. 32° 40′. These are reported as *heglig* colonies and of fair size but none so big as the one at Lat. 6° 38′, Long. 33° 7′.

Ngacitiligwan and presumably Capt. Renny's phallic J. Shotina are old volcano cores. The size of the tree colonies seems to be limited only by the number of trees. On what do the birds feed during the breeding season ?

A LINGUISTIC CURIOSITY in Equatoria Province: An interlabial b.

By Fr. Carlo Muratori, V.F.M.

In the Lotuxo language (Torit District), a peculiar kind of *b* has been found, namely a strong *b* (double *bb*) preceded by glotal stop and pronounced by putting the tongue tip well apparent between the lips: *'bbh* (assuming *h* as a symbol for interdental sounds in the Sudan).

As far as I know, it exists only in one instance, *viz.* a descriptive adverb for a thunder-clap: *'bbhie'*, in which the terminal vowel seems to have the glottal stop too.

E.g. *abak axilai 'bbhie'*, a thunder-clap fell down.

THE FOURTH CATARACT

By Terence Gray

PRELIMINARY archaeological survey of the 4th. Cataract region was undertaken on behalf of the Commissioner for Archaeology during the months of January and February 1949.

The expedition consisted of Thabit Eff. Hassan, Antiquities Officer, and myself, Mitwalli Hassan Ali—a skilled workman from Quft in Egypt, servants and camel-transport.

The survey started from Karima and ended at El Kab, and was operated from 10 camps, all on the " East " bank (Nile East, geographical West) : Umm Duweim, opposite Uli Island, Shebabit, Hillet el 'Umda, Shatab, opposite Berti Island, Esh Shereik (opposite Boni Island), opposite Us Island, Hillet Es Sidr, Amarin (Kanissa). All the accessible islands were examined as well as the back-desert area. 211 sites were recorded, 350 photographs taken, over 150 bags of sherds, flints and surface material were collected. Until this material is studied, pots reconstructed, and comparison made with material from other sites it would not be practicable to assess the results of the investigation.

Strange as it may seem, for an area lying between a river and a railway, there appears to be no trace, either in record or in local tradition, of any European having traversed this area on the " East " bank. This singular circumstance only becomes understandable when Birti Island is passed. Hereafter the cataract becomes a wilderness, the river can no longer be followed either by camel or donkey, and the isolated farmsteads, supported by cash-crops grown on the river bed, are approachable only from the back-desert.

These approaches, and the tracks in the back-desert, are more difficult and dangerous for camel-transport than the Batn-El-Hagar. When Shirri Island is reached the rocky wilderness begins to give place to the golden sands of the high desert which come down to the river's edge.

The essential factor governing the incidence of archaeological remains, other than Palaeolitic and Neolithic, of an age when Man lived largely by hunting and fishing, is the irrigable area. Whereas usually in the Nile Valley this is confined to the belt on two banks on which the river has deposited silt, in this cataract area, where islands are scattered like a flock of goats, the number of silt-covered river banks in any given 10 kilometres may be anything up to a dozen. On any of these islands on which a pit was opened, either by the Egyptian Irrigation engineers or by ourselves, several metres of silt were revealed,

which explains the considerable population which the region supported in past times.

In general every island of any size presents beyond the belt of present cultivation one or more habitation-areas, one or more cemeteries, and remains of a Neolithic character in the interior. The variety of sherds on many of these sites is extensive and appears to cover a great part of the historical period, the Meroitic and Christian being regularly represented as the final occupation.

There are also a number of forts and fortified areas, frequently destroyed, belonging to the Christian period, throughout the 4th. Cataract region.

The multitude of sites, habitation and burial, available for study, should make it possible, in this relatively undisturbed area, to obtain a cross-section of life in the northern Sudan throughout historical time. Many graves will be found to have been robbed in antiquity ; many cemeteries have been seriously damaged by *mārog*-[1]diggers ; on the other hand there appears to be a good deal of undisturbed material.

It is unlikely that products of high civilisation will be found in any quantity if the area is scientifically excavated. It would appear to have been always a poor area, somewhat isolated, experiencing only the backwash of great events. But its scientific study might well throw light on obscure periods of Sudanese history.

The islands appear to have been more thickly populated and to contain sites of greater archaeological interest, with exceptions, than the " East " bank in general.

The more important islands examined were : Uli, Saffi, Umm Har, Dawanib, Bana, Tetami, Magassir, Umm Duras, Amri, El Kushi, El Mishi, Umm Kumbatut, Umm Gebeir, Abu Dassi, Birti, Umm Hamdalla, Boni, Us and Shirri.

The expedition received much kindness and help from the Governor of the Northern Province and his staff, the District Commissioner at Merowe and his staff, the District Commissioner at Berber, the engineers of the Egyptian Irrigation Dept., and the 'Umda of Manasir.

[1] *Marög* (usually translated " compost") from ancient graves is considered beneficial to cultivation. — *Ed.*

RECENT BOOKS AND ARTICLES OF INTEREST TO SUDAN READERS

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NOTES:—1. The attention of readers is drawn to the forthcoming publication of *Agricultural Science in the Sudan. A Bibliography to* 1948 *with selected Abstracts*, by R. L. Knight and B. M. Boyns. It is hoped that this will appear before the end of 1949.

2. The above bibliography does not include school books or articles dealing only with the transient political situation.

BOOK REVIEWS

TARIKH MULUK AL SUDAN (History of the Kings of the Sudan—in Arabic). Edited with an introduction by Mekki Shibeika. *Khartoum McCorquodale & Co.* 1948. (Gordon Memorial College Historical Series No. 1).

While hunting in the archives of Cairo, Mekki Eff. Shibeika came across a famous document sent by Gordon to H.H. the Khedive of Egypt, with a covering letter (dated Ramadan 3rd., 1295 A.H., i.e. 1877 A.D.), stating that he, Gordon, had procured a copy of a pamphlet, in which was recorded the history of the Kings of the Sudan until the Turco-Egyptian occupation of the country. The pamphlet went on to tell the story of the Egyptian Governors General, from the time of Ismail Pasha down to the time of Mumtaz Pasha, Governor General of the South of the Sudan. On his resignation, Gordon was believed to have carried home another copy, which he deposited in the British Museum.

This pamphlet—the only authentic document in existence—has ever since been the only reliable source for many historians. General Stewart in his *Report on the Sudan*, Shukeir in *Tārīkh el Sudān*, Mac Michael in *The Tribes of Northern and Central Kordofan*, Jackson in *A Tooth of Fire*, and several others, have to a greater or lesser extent drawn their information from this pamphlet.

Despite the great importance attached to this document, it has not been known for certain who its author was; hence the long and tedious research work begun by Shibeika who, in his capacity as lecturer in the history of the modern Sudan in the Gordon Memorial College, had access to the Civil Secretary's library in Khartoum and to the national libraries and archives of Abdin Palace in Cairo.

Shibeika was disappointed in MacMichael, whose translation of and commentary on the pamphlet ended with a guess: that the author might have belonged to the Yagubab tribe, was probably a follower of the Sammania sect and seemed to have lived for some time in Khartoum, presumably a Government official. That was all. Jackson, however, was more encouraging. Although there was no mention of the original author, Jackson admitted that " this History was set in final form by Sh. Ibrahim Abdel Dafia with additions from the History of El Zubeir Wad Dawwa." Another authority, Shukeir, mentions among his sources the two books written by El Zubeir and Ibrahim Abdel Dafia.

In Cairo, Shibeika came across a copy, different in style and detail from those in the Civil Secretary's library and ending with Ahmed Pasha Abu Widān. In this copy, the author had written an autobiography. Shibeika found another different copy in possession of Sh. Omer Dafalla of Omdurman in which was written " by El Zubeir Wad Dawwa." Thus, armed with three pamphlets, one ending with Abu Widān, the second with Mumtaz, the third with Musa Hamdi, with the author's name, Shibeika settled down to the task of checking and comparing.

It was not difficult for Shibeika to arrive at the conclusion that the three pamphlets were one and the same ; and that four authors handled it in succession, the first being Sh. Ahmed Katib El Shouna. Then followed El Zubeir Wad Dawwa, El Amin El Darir and Ibrahim Abdel Dafia. Each of these historians, in his turn, treated the pamphlet in his own way and style with few omissions or additions.

After the introduction, Shibeika presents the text of the pamphlet, which begins with " Hereinafter is recorded the History belonging to the land of the Nuba and the story of its Kings, beginning with the Fung until my time, including the Turks, their successors, and how the Fung Kingdom was destroyed. God knows better."

The third part of the book is a commentary, which clarifies vague expressions or queer place-names in the pamphlet. It gives, in addition, quotations from earlier historians and official correspondence, to supplement, corroborate or explain certain events of importance.

This book is, undoubtedly, a great achievement, depicting the spirit of investigation and scientific research now brewing in the young university. It is true that the book, in general, is untidy, with no index or table of contents, and printed in poor type ; but this does not decrease its great historical value, nor the charm of reading its contents.

AWAD SATTI.

THE BIRDS OF TROPICAL WEST AFRICA, VOL. VI. By D. A. Bannerman, M.B.E., M.A., Sc.D., F.R.S.E. *Crown Agents for the Colonies*, 1948. 35/-.

The sixth volume of Mr. Bannerman's work covers a further seven families of the Passerines, the Tits, the Crows and Ravens, the Starlings, the White-Eyes, the Sun-birds, the Tree-creepers, and the Finches, Buntings and Sparrows.

The text follows closely the lay-out of the previous volumes which have been reviewed in this Journal as they appeared, and is illustrated by a wealth of coloured plates and text figures in line or half-tone by

such artists as Messrs. George Lodge, Roland Green, Philip Rickman, and Henrik Grönvold.

In the Sudan these seven families are represented by 70 species, and of this number 47 species or closely related subspecies are described in the text, 44 being illustrated, most of them in the coloured plates, the rest in half-tone drawings. Thus within these seven families this volume covers 67% of the Sudan members. The following table shows the numbers of species in each family in the Sudan according to Bowen's List, and in column 2 the number covered in this volume, and in column 3 the number of these illustrated :—

Family				
Paridae	(Tits)	6	4	4
Corvidae	(Ravens & Crows).....	6	4	3
Sturnidae	(Starlings).....	16	10	8
	(Ox-Peckers)	2	1	1
Zosteropidae	(White-Eyes)	2	1	1
Nectariniidae	(Sun-birds)	15	12	12
Certhiidae	(Tree-Creepers)	—	—	—
Fringillidae	(Finches).....	4	4	4
	(Buntings)	8	4	4
	(Sparrows)	11	7	7

In the Index of coloured plates, under plate 6, the Latin generic name of the Long-tailed Glossy Starling is given in error as *Lamprocolius*, whereas in the text it is given as *Lamprotornis*. The latter is correct.

Until a text book with full text descriptions and plates is produced for the birds of the Sudan, Bannerman's *Birds of West Africa* will remain the most useful work of reference for those interested to study, and the price even at 35/- a volume is well worthwhile. P. Hogg.

CONTRIBUTION A L'ETUDE DU SAHARA OCCIDENTAL, publiée sous la direction de Th. Monod : FASCICULE II, 1939. *Publications du Comité d'Etudes Historiques et Scientifiques de l'Afrique Occidental Francaise.*

This publication consists of three parts *viz.* (1) Roches éruptives et métamorphiques by E. Jeremine, (2) Phanérogames by Th. Monod, (3) La langue azer by Ch. Montelli ; all three parts being associated with the same area, *viz.* that known as Mauretania including Tagant, Adrar, Aouker etc., and the Soudan including Hodh, Azoouad, the regions of Taoudeni, Agueraktem, Hank, Tiniétrine, Tilenise etc.

The first part gives an interesting account of the volcanic and

metamorphic rocks of this district and includes a series of micro-photographs of sections from typical rocks, as well as photographs illustrating the terrain and formation of the rocks.

The second part gives a list of the plants found during a botanical survey by the author. The list is comprehensive and contains many plants occurring in the Northern and Central Sudan revealing affinities between the two regions. M. Monod then proceeds to give an account of his intinerary and to divide the area into its geographical regions and relate to each region its characteristic flora. A number of photographs of dried plant specimens accompany the article and the whole constitutes an important contribution to the botanical knowledge of this area.

In the third part the author gives an account of the Azer language, a well-defined dialect of the Sahel, which at one time was widely used as a commercial intertribal language. Its importance declined on the arrival of the Arabs, who drove back the blacks of the Sahara and subjugated the Berberines. The article contains a short grammar of the language and concludes with an Azer-French and French-Azer vocabulary.

CONTRIBUTION A L'ETUDE DE LA VEGETATION DU SENEGAL. By Jean Trochain. *Mémoires de l'Institut Francais d'Afrique Noire No.* 2. 1940.

Dr. Trochain commences this valuable and comprehensive work on the vegetation of Senegal with a consideration of three factors that influence the distribution and organisation of all vegetation, *viz* the climatic, the edaphic (soil) and the biotic, and discusses their effect in Senegal. Topography, according to the author, has little effect on vegetation in Senegal. This discussion is followed by a description of the technical methods employed in making this study, and the author concludes this general introduction by a description of the phyto-geographical regions of French West Africa in general and Senegal in particular. Then follows the main body of the work, a study of the vegetation of Senegal. It is impossible in a very brief review to indicate the immense amount of information contained in this voluminous study. Much of the vegetation of Senegal is similar to that found in the southern Sudan, except where abound species peculiar to West Africa, and a detailed comparison of the vegetation of Senegal and the southern Sudan would make an interesting and instructive study. Dr. Trochain concludes his treatise with a series of excellent photographs illustrating typical Senegal scenery and plant formation. F. W. ANDREWS.

BIBLIOGRAFIA DI STUDI AFRICANI DELLA MISSIONE DELL' AFRICA CENTRALE. Compiled by Fr. S. Santandrea, F.S.C.J. Missione Africane, Verona. 1948. pp. 28-168. £.1 or 5 Dollars.

This the first of a series of monographs to be produced at intervals by the African Missions of Verona and to be called *Museum Combonianum* in honour of their founder. The present volume is a bibliography of all serious writings published either by missionaries themselves or on the Mission to Central Africa, during the past century. The compiler is well known for his devoted researches in the southern Sudan.

The next volume in the series will be a *Dinka Grammar* in English by Fr. A. Nebel.

ENGLISH-BARI-LOTUKO-ACOLI VOCABULARY. Edited by Fr. C. Muratori, F.S.C.J., Catholic Mission Press, Okaru (S. Sudan), 1948. pp. 270.

This useful book is based on Bari vocabularies by Mrs. Gibson (of the C.M.S.) and Fr. Spagnolo, an Acoli dictionary by Fr. Crazzolara and additions by other hands, with financial assistance from the Education Department. It gives the four languages in parallel columns and its appearance would have been enhanced if it had been found possible to separate the English and Bari into separate columns, as in the case of the other languages. There are grammatical notes on each language at the end, but they are so brief that they do not help very much, and they are not really authoritative.

CORRESPONDENCE

ASCORBIN (VITAMIN C) VALUES OF SUDAN FOODS

The Editor, *Sudan Notes and Records.*

Dear Sir,

In 1939 I had under observation the inhabitants of Ulu in the southern Fung for some four months during which they were on a diet improvised from bush foods because locusts had destroyed their food crops. The famine staple was the poisonous wild cluster yam *D.dumetorum* Pax. I saw these people on two occasions, after four and eight months of partial famine experience respectively, and was surprised to find no evidence of important malnutrition other than a mild thiamin (vitamin B^1) deficiency. I had expected scurvy to make its appearance. Crude tests with dichlorophenolindophenol dye suggested that possibly this yam and certain other bush foods used to a lesser extent, such as the gingerbread nut (*H.thebaica, dom*), had useful values in ascorbin (vitamin C).

In 1946, having been informed by medical officers who knew the district, that the riverain people of the Batn el Hagar in Dongola were malnourished, I took the opportunity of a tour through the area to stay two days at Attiri and examine the diets of eight families. I found that the only foods contributing ascorbin to the diet were cooked in the relish (*mulāh*) with natron—a third or more of which is soda—for a relatively lengthy period. One such cooking was timed and took seventy-five minutes. Cooking of this nature may be expected practically to destroy any ascorbin originally present. In twenty-five persons examined in the village I found six cases of scurvy. In Halfa hospital nearby, in patients deriving from similar living economies, I found four more.

The desert community of the Batahin of Abu Deleiq rely for their ascorbin supply, odd though it may seem, very largely on their milk; and in May and June, when this has very greatly declined in quantity, scurvy cases may be found by those particularly looking for them, unless by now the trade at this season in fresh vegetables from Shendi has greatly increased. A deficiency of ascorbin increases the period of invalidism in the sick and injured. The point I am making is that in the central and northern Sudan ascorbin deficiency in certain communities may be of very considerable seasonal importance and a

knowledge of the ascorbin content of Sudan foods, both cultivated and from the bush may be of value.

There is a test with a dye, dichlorophenolindophenol, which, in the hands of the trained chemist, gives the value for ascorbin in the material tested. About 1938 this dye appeared on the market and at the time seemed to offer a simple means for testing for ascorbin values in the field. I carried out many such tests in the Fung and the results are shown in the Table given here.

TABLE.

VALUES OBTAINED FOR THE PRESUMED ASCORBIN (VITAMIN C, ASCORBIC ACID) CONTENT OF VARIOUS SUDAN FOODSTUFFS IN MG. PER 100 G.

(*N.B.—No attempt was made to exclude the effect of interfering substances and the values are therefore suggestive only. An appropriate intake for an average working man may be put at* 30-50 *mg. per day.* 100*g.* = 3.7 *oz.* = 32 *dirhems*)

FOODSTUFF	DATE	PLACE	VALUE	REMARKS
Milk, human	24/2/40	Sennar	1.80	Raw. Fixsen & Roscoe (1940) 1.2—10.8[1]
" , cow	24/2/40	"	1.60	Raw. Fixsen & Roscoe (1940) 0.3—2.89[1]
" "	25/2/40	"	1.25	Boiled.
" "	22/2/40	Roseires	1.10	Raw.
" "	22/2/40	"	1.00	Boiled.
" , she-goat	24/2/40	Sennar	1.70	Raw. Fixsen and Roscoe (1940) 0.9—8.5[1]
" " "	25/2/40	"	1.10	Boiled.
" " "	22/2/40	Roseires	1.50	Raw.
" " "	22/2/40	"	1.09	Boiled.
" , ewe	24/2/40	Sennar	1.60	Raw.
" "	25/2/40	"	0.80	Boiled.
" "	22/2/40	Roseires	0.66	Raw.
" "	22/2/40	"	0.69	Boiled.
" , she-camel	24/2/40	Sennar	0.93	Raw.
" " "	25/2/40	"	0.70	Boiled.
" , she-ass	22/2/40	Roseires	1.90	Raw.
" " "	24/2/40	Sennar	0.80	Raw.
Milk, she-ass	25/2/40	Sennar	0.20	Boiled.
Millet beer, *asaliya*	Jan., 1939	"	4.00	Made entirely from sprouted grain
" " , *marisa*	Jan., 1939	"	2.20	Half sprouted grain, half millet-flour paste

(1) Values given under "Remarks" are taken from Tables of the Vitamin Content of Human and Animal Foods by Fixen, B.M.A. and Roscoe, M.H. (1940) *Nut. Abst. Rev.* 9, 795.

FOODSTUFF	DATE	PLACE	VALUE	REMARKS
Hospital relish (vegetables, spices, salt etc.), *mulah*	Jan., 1939	Sennar	2.80	Sennar Hospital, after cooking
Tamarind, *Tamarindus indicus, aradeib*	22/2/40	Roseires	100.00	Marketed commercial cake or mass, well pounded, and diluted to allow of colour appreciation. Fixsen and Roscoe give 15.1-41.8
Palmyra fruit, *Borassus flabellifer, doleb*	10/2/40	Singa	12.50	Pulp only
Palmyra fruit, *Borassus flabellifer, doleb*	12/2/40	"	15.00	Pulp only
Gingerbread nut, *Hyphaene thebaica, dom*	?	"	16.50	Dry nuts, edible portion
Tebeldi fruit, *Adansonia digitata, gangoleis.*	Jan., 1940	Roseires	100.00	Pulp powdered
Desert date, *Balanites aegyptiaca, lalob.*	Jan., 1940	"	50.00	Value is for the pulp only—fresh gathered.
Lime, *Citrus medica*	Jan., 1940	"	5.00—10.00	Pulp only.
Jujube, *Ziziphus spina-christi, nabakh*	Jan., 1939	"	50.00	Skin and pulp 24 hours after picking.
Tomato, *Lycopersicum esculentum*	Jan., 1940	"	5.5	Whole fruit.
Sweet cassava, *Manihot aipi, buffra*	April, 1939	Sennar	2.20	An occasional food in the Fung.
Bitter cassava, *Manihot utilissima, lota*	Dec., 1939	Kurmuk	0.50	An occasional food in the Fung.
Cluster yam, *Dioscorea dumetorum, umm talga, shatta, umm bico*	Jan., 1939	Ulu	6.60	Peeled, poisonous. This is an average value for the fresh tuber.
Cluster yarn	April, 1939	Roseires	30.00	Peeled. Probably cooked with tamarind.
" "	Dec., 1939	"	4.50	Peeled.
Potato yam, *Dioscorea sativa, majiru*	Dec., 1939	"	1.00	Cultivated form.
Winged yam, *Dioscorea alata, el gheita, umm jiko*	Apr., 1939	Kurmuk	3.30	Cultivated form

FOODSTUFF	DATE	PLACE	VALUE	REMARKS
Wild bean root, *Vigna vexillata, babun.*	April, 1939	Kurmuk	0.00	Roots or tubers eaten in rains.
Wild bean root, *Vigna vexillata, babun el khala*	Dec., 1939	Roseires	0.50	Roots or tubers eaten in rains.
Bean root, *babun el girf*	Dec., 1939	"	0.45	Cultivated form.
Water lily, *Nymphaea lotus, suteib.*	Dec., 1939	"	0.80	The root—commonly eaten.
Hydnora sp., tartus	Dec., 1939	"	2.20	Parasitic plant on roots of *A.arabica.* Eaten as an occasional food.
Lanea sp. leiyun, leiyut.	Dec., 1939*k*	Kurmuk	4.00	Root eaten as an occasional food.
Amorphophallus sp., bokhat.	Dec., 1939	Roseires	0.80	Poisonous tuber used as an occasional food.
Amorphophallus sp., masik.	April, 1939	Ingessana hills	2.50	Poisonous tuber used as an occasional food.
Tacca leontopetaloides, faranso.	April, 1939	Qeissan	5.70	Root or tuber eaten as famine food.
Tacca leontopetaloides, franson.	April, 1939	Kurmuk	6.60	Root or tuber eaten as famine food.
Apas (Berta).	April, 1939	Roseires	5.00	Root or tuber of green creeper ; a famine food
Rogo.	Dec., 1939	El Ruakib, Anakhleiba (nr. Singa)	25.00	Fellata village. Suspected ennobled *D. dumetorum* tuber.
Curculigo pilosa, umm sa'af.	Nov., 1939	Roseires	00.00	Very poisonous. Killed 15 people in Wisko area.

However, it was soon (1940) appreciated that there are a number of so-called "interfering substances" which may distort the apparent values obtained for ascorbin and certain special methods are required which put this dye test out of consideration as a simple field test, at any rate in the hands of one not specially skilled and adequately equipped.

The table shows the tentative or suggestive values obtained by me using this unamended test in 1939-40 for various foodstuffs in the Fung.

The values for some may be far from the truth but in any case they are sent herewith in the hope that someone working in chemistry—possibly some of the senior Gordon College students—may feel that it would be useful to confirm or correct the values suggested as possibly obtaining for these Sudan foodstuffs. The milk values compare with those published and are probably valid. Of particular interest would be the correct values for bush fruits, milks in the hot season, and camel's milk at all seasons.

Yours truly,

N. L. CORKILL.
(*Formerly Sudan Medical Service*).

Liverpool School of Tropical Medicine.
20/5/48.

BREEDING OF TEMMINCK'S COURSER

The Editor
Sudan Notes and Records.

Dear Sir,

It may be of interest to record a case of breeding of Temminck's Courser (*Cursorius Temmincki*) in Kordofan in 1948.

On several dates between 12th and 16th July I noticed a pair of above species on a stony upland about 8 miles from el Obeid whose behaviour suggested presence of eggs or young.

On 25th July I obtained an adult female and juvenile 4 to 5 weeks old at the same place, and evidence suggests that breeding had taken place there.

Mr. J. D. Macdonald of the British Museum had kindly confirmed the identification from the specimens and they are now in the Khartoum Museum.

An examination of available literature suggests that this courser is not often met with in the Sudan and I can find no previous case of breeding recorded.

Yours etc.,
F. W. BLAKE.

c/o Posts & Telegraphs Dept.
Wad Medani,
28th April 1949.

السودان في رسائل ومذكرات

Sudan Notes and Records.

Vol. XXX, 1949.

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SUDAN NOTES AND RECORDS

FOUNDED 1918.

السودان في رسائل ومدونات

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Back numbers of this journal, with certain exceptions, and off prints of certain articles can be obtained on application to Hon. Treasurer, to the Sudan Bookshop Khartoum, or to Messrs. Luzac & Co. Ltd. 46, Great Russell Street, London, W.C.1. Back numbers are charged at the published price, with the exception of certain scarce volumes.

Correspondence regarding exchange of publications should be addressed to Librarian, Gordon College, Khartoum.

An Index of the first twenty volumes is printed at the end of Vol. XXI (1938) Part II.

The Editor,
P. O. Box 555,
Khartoum.

Hon. Treasurer,
P. O. Box 555,
Khartoum.

Transliteration of the Arabic Alphabet

adopted by the Editors of *Sudan Notes and Records*

ا	at beginning of word omit, hamza (')	ذ	dh (coll. d)	غ	gh
	elsewhere	ر	r	ف	f
		ز	z	ق	q (coll. g)
ب	b	س	s	ك	k
ت	t	ش	sh	ل	l
ث	th (coll. t or s)	ص	ṣ	م	m
ج	j or g	ض	ḍ	ن	n
ح	ḥ	ط	ṭ	ه	h
خ	kh	ظ	ẓ	و	w
د	d	ع	'	ي	y

VOWELS.				DIPHTHONGS.
fatḥa	a,	lengthened	ā	ى—ai (as in aisle).
kasra	i,	„	ī	و—au (as in mauser).
ḍamma	u,	„	ū	

The ل of the article always remains *l*.

The silent *t* (ة) is omitted.

NOTES.

1. The system is not applied to well-known names, such as Khartoum, Omdurman, etc.

2. The vowel sounds of *e* in "get" and *o* in "hot" with the corresponding long vowels (*a* in "gate" and *o* in "home"), which occur only in the colloquial, are expressed by e, o, ē, ō.

e.g. beled, Moḥammed, bēt (or beit), ḥōsh.

Ei may be used as alternative to show the long ē.

3. In geographical names the conventional spelling used by the Sudan Government Survey Department is followed, although not always agreeing with the above transliteration.

4. At present phonetic type is not available for proper reproduction of non-Arabic African languages.

EDITORIAL NOTES

AMONG the articles in this issue is one on fishing in the Bahr el Ghazal by Captain Stubbs who was for many years District Commissioner at Aweil. He had originally intended that his article should be illustrated with coloured drawings made by Mrs. Stubbs (and the Rev. Alghisi), but the Committee realised that adequately to reproduce these in four-colour printing would go far outside the normal scope of this Journal. When the Sudan Government generously made a grant to cover the special costs, it was eventually decided to take advantage of the occasion to produce a proper handbook of Nile fish and it is now expected that this will appear in a few months time. Dr. H. Sandon, Reader in Zoology at the Gordon College, has not only written descriptive notes, but has checked up the illustrations and added line drawings of fish not illustrated.

Increased attention is now being given to fishing in the Sudan, as also in many other parts of Africa, with a view to developing this important source of food for internal consumption or export: the work of the Jonglei Investigation Team has emphasized the importance of fish in the diet of the Nilotic. It is hoped therefore that this handbook will be of general interest and value. It will be on sale to the public at the price of 25 P.T.

* * *

ETHNOS, the Journal of the Swedish Ethnographical Museum at Stockholm, (1948, Nos. 3-4), contains an interesting article by Professor Lindblom on mosquito "nets" in Africa, that is to say, indigenous forms of protection against mosquitoes other than the European-introduced gauze "net" as we know it. This protection may take the form of finely woven material or basketwork, and our earliest informant on the subject is, as usual, the indefatigable Herodotus. The article quotes no examples from the Sudan, and it would be interesting if any reader could produce information on any such indigenous form of protection to be found now or formerly in this country.

* * *

Mr. J. P. GREENLAW writes that he is preparing a book on the *Architecture of Suakin* to record the memory of this little gem of Islamic culture which is now in the last stages of decay. He wishes to ask if anyone is prepared to help this cause by sending him any photographs he may have of the town. Should they specify that they want the pictures back he will of course return them. The older the photographs are the better.

All correspondence should be addressed to :

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SUDAN NOTES AND RECORDS

Vol. XXX. Part II. 1949

THE DEVELOPMENT OF SUDAN COMMUNICATIONS.[1]

By H. A. Morrice.

PART III. — ROADS.

1.—Types of Construction.

In this article the word "Road" will be understood to mean a continuous paved strip with a surface smooth enough to carry modern wheeled traffic at ordinary speeds without excessive shocks. To qualify as a road such a strip must normally be available for this purpose at all seasons of the year and in all weathers. Consequently it must be properly drained, and provided with bridges and culverts to suit the local topography. A road in this sense is to be sharply distinguished from a track, which is never continuously surfaced, seldom provided with adequate drains or bridges, and usually impassable during the rains. In certain circumstances it is possible for tracks to be almost as useful during the dry season as roads, but when it rains they are practically always greatly inferior and not infrequently totally useless. Even when dry, tracks can compare with roads only if the traffic is light and the natural soil suitable, being neither too friable owing to excess of sand nor too liable to crack owing to excess of clay. Unless the traffic is exceptionally light, careful and continuous maintenance, preferably with power graders, will be essential even then to prevent rapid deterioration. Moreover, during the rains no traffic whatever can be allowed while the surface is still wet, not primarily on account of the danger that vehicles may get bogged, but mainly because at such a time one single vehicle can ruin the track. In many parts of the world tracks that are carefully maintained with power graders are known as dirt roads; in the Sudan it is customary to go further and to honour with the name of road practically any track over which an adventurous motorist can coax his vehicle.

[1] The first section of this article appeared in Vol. XXX, Part I. Part III was delivered as a lecture to the Philosophical Society of the Sudan.

To confound roads with tracks in this manner is confusing, and the practice is better avoided.

In the sense above defined the Sudan has practically no roads. Apart from a few miles in and near Khartoum and in the centre of one or two other towns such as Wad Medani, Atbara, and Port Sudan, the only important exception is to be found in the south, and not, as might have been expected on general grounds, in the neighbourhood of the capital city. To understand the reason for this anomalous development we must consider the elementary surface geology of the Sudan in so far as it affects road-building. From this point of view the country can conveniently be divided into four basic regions as follows :—

(1) The sandy plains of the north.
(2) Hilly country with numerous rocky outcrops, as near the Red Sea or in the Nuba Mountains.
(3) The clay plain of the central Sudan, most of which lies in the Upper Nile province.
(4) The laterite belt that covers most of the Bahr el Ghazal province, and a large part of Equatoria.

We shall now consider the suitability of each of these regions, firstly for the development of tracks, and secondly for the construction of roads.

The sandy northern plains of the Sudan are eminently suitable for the development of tracks in almost any desired direction. Usually there is no need even to clear away vegetation, and local rainfall is so infrequent that drainage problems can be disregarded. The most serious obstacles are patches of loose sand such as are often found in *wadi* beds, but vehicles equipped with modern low pressure tyres seldom sink in if driven with discretion. In the exceptional case when they do sink in, vehicles can readily be freed by using sand channels ; the process may sometimes be tedious, but it is straightforward and seldom difficult. (A sand channel is a light plank made of perforated sheet-metal). If a particular *wadi* crossing constantly gives trouble the simplest remedy is to lay a mesh wire carpet such as light army track, which consists of No. 8 fence wire in diamond mesh at 3" centres made up into rolls 10 feet wide and about 40 feet long. Even after one of the infrequent falls of rain a sandy track will be passable provided that no *wadi* to be crossed is in spate, but patches of soil with a significant clay content may give trouble. An area like the northern Sudan is almost ideal for the development of tracks with little or no expenditure, and consequently there is, in the early stages of development at least, little inducement to build proper roads.

In the clay plains of the Upper Nile tracks are not so easily made by the vehicles themselves, but nevertheless it is usually possible during the dry season to drive across country in any desired direction unless there is water or possibly acacia forest in the way. The process is, however, usually tedious in the extreme, for heavy clay cracks badly as it dries and vehicles are often forced to travel in bottom gear at walking pace as they lurch from side to side. Moreover, in practice flooded depressions and drainage lines are often serious obstacles demanding the construction of long, though usually fairly low, earth banks. Hence there is in the Upper Nile province a considerable inducement to build rough tracks by clearing long grass, smoothing the surface as far as possible, and building the necessary banks. Such tracks are often bad, but once they have been established one can normally expect to average at least 15 m.p.h. and sometimes more. Most of them have been built with local labour which is neither abundant nor of good quality, and in the circumstances the achievement is excellent. To raise appreciably the prevailing standards will undoubtedly demand the use of modern machinery. It must be clearly understood that a clay track with a wet surface is never safe for vehicles and usually impassable; even if cars can get through with a struggle they will certainly ruin the track. For this reason all tracks in the Upper Nile province are closed during the rains for about six months each year. They cannot be opened until they are perfectly dry because neither sand channels nor mesh wire tracks are of much use for crossing damp patches. These devices act, not only by the obvious method of diminishing the bearing pressure under the wheels, but also by surcharging the surrounding soil and so increasing the pressure which the soil under the wheels can withstand. This latter effect is most important, but it depends on the angle of internal friction of the soil; hence it does not occur with a purely cohesive soil such as clay. Those who have struggled with vehicles bogged in wet clay will add to this theoretical explanation the fact that the coefficient of friction between tyre and sand channel is greatly reduced in the presence of water.

Neither of the two remaining regions can normally be traversed by wheeled vehicles without a considerable amount of preliminary work. Tracks are most easily built in the laterite country, which is usually fairly flat; the absolutely essential work is then mainly confined to clearing the scrub. Such tracks will be passable during the dry season when there will normally be little or no water in the streams. During the rains, however, the streams will be swollen, and the track itself will probably be impassable even if they are bridged.

As for the hilly districts, they are not well suited for the rapid construction of tracks; a considerable amount of work will often be required and even then the going is likely to be rough. In this type of country nothing short of a properly drained road with bridges over the principal watercourses is likely to be of much practical use. This concludes our analysis of each region according to the ease with which tracks can be built; we shall now consider how each is suited for the construction of roads as defined at the beginning of this section.

There can be no doubt that the lateritic area is the easiest in which to make reasonably good roads. Laterite is common in the tropics where natural drainage is good and rainfall fairly high; in the Sudan it is seldom found north of the 800-millimetre isohyet. The term is not very precise, but laterite can be roughly defined as "a hard mixture of sand-clay nodules coloured red with iron salts." It is easily excavated, can be readily compacted to form a good road, and is very common in those areas where conditions in general are suitable. For these reasons excellent red roads are to be found, not only in the southern Sudan, but also over most of Uganda, the north-eastern part of the Belgian Congo, and a large part of French Equatorial Africa and the French Cameroons. The suitability of laterite for road-making and the ease with which tracks can be made in a sandy plain combine to explain the paradox that the Sudan has developed her first road system in the primitive south rather than in the more civilized north. Excellent for moderate traffic as laterite roads are, it has been found in Uganda that "bitumen surfacing must be introduced where traffic is relatively heavy." This is only to be expected, and the original laterite will form a good foundation.

The next most favourable region for building roads is the sandy north, for it has been found that the addition of only 5 or 6% of cut-back bitumen suffices to stabilize dry sand. This process can be used for sandy loams, but the proportion of bitumen needed increases with the clay content and soon becomes prohibitively high. Sand-bitumen carpets have been used extensively in Egypt, often with the addition of a wearing course of crushed stone chips. Such roads have been loosely described as "mix-in-place," a term which should mean that the ingredients are mixed on the ground with blade graders by forming a succession of windrows. It is difficult to get satisfactory results with sand and bitumen in this way, so in Egypt they have usually been premixed and then spread either mechanically or otherwise. Sand-bitumen roads with light wearing courses appear to be admirably suited to the northern Sudan, where sand is usually available on site and bitumen

can be imported quite cheaply from the oilfields of the Middle East. Stone suitable for crushing to form the wearing course will normally be available not far away and can be brought in by lorry in the comparatively small quantities required.

There are parts of the northern Sudan where the soil contains so much clay mixed with the sand that the use of bitumen becomes uneconomical. It may be possible to bring in pure sand by lorry, but the quantities involved will be large and the possibility of stabilizing the soil with cement offers a cheaper alternative. In this process the soil is first pulverized, then damped, and finally mixed in place with dry cement which has been distributed in sackfuls at regular intervals in accordance with the proportion desired. Soils containing up to 35% of clay can be treated with not more than 10% of cement provided they are otherwise suitable, and the process appears to be well suited for certain parts of the country. One advantage is that cement can be produced in the Sudan, unlike bitumen; on the other hand a bituminous wearing surface will probably be necessary to protect the soil-cement carpet.

In hilly districts materials for making good roads are almost always easy to find, but construction is much more expensive than in the lowlands because it cannot take the simple form of merely laying a carpet across a plain. Earthwork on a considerable scale will usually be unavoidable, together with bridges, culverts, and even retaining walls. Because stone is normally easy to find locally, roads through hilly country are commonly provided with a soling or foundation course of solid stone blocks up to one foot thick. On this is laid a course of bitumen-bound macadam perhaps 3 inches thick; if the traffic is heavy a wearing course may be added about $1\frac{1}{2}$ inches thick. Stone for these courses can usually be found and crushed near the site; it is laid either hot mixed with pure bitumen or cold mixed with bitumen emulsion. Bitumen is essential because water-bound macadam will not stand up to modern traffic especially in hot climates. In Eritrea and Ethiopia during the years before the recent war the Italians built many miles of roads consisting of bitumen-bound macadam on stone soling. Such roads are expensive in the first place, but they provide fine lines of communication through country otherwise impassable for wheeled traffic, as was very evident in Ethiopia. Moreover they last well provided always that small repairs are not postponed unduly and that drainage channels are kept clean so that the road nowhere degenerates into a watercourse.

There remain for consideration the clay plains which unquestionably

present the most awkward problem of all. The basic difficulty is that heavy clay cannot be stabilized by adding small quantities of bitumen, cement, or any other known material. It is true that some clays can be burned to make brick, a fact which suggests that it might be possible to stabilize such soils by some form of heat treatment. Attempts have, in fact, been made to do so, but not apparently with much success. One trouble is that not all clays will vitrify; another is the high fuel consumption and difficulty of simulating on site the process of roasting in a kiln followed by a gradual cooling off. A more elaborate method would be to burn bricks on site and use them for paving the road; in the U.S.A. there are first class roads designed for heavy traffic that are paved with brick, but the foundation is a concrete slab and the bricks are of high quality. It might be possible to devise for the Sudan a method of using bricks in moderate quantities to provide a satisfactory road surface, but the prospect is not very hopeful and much experimenting would certainly be required. Good roads could, of course, be made by importing large quantities of stone and laying bitumen-bound macadam on soling, but the expense would be enormous. Perhaps the most promising method of making roads across clay plains is to add enough sand to the natural soil for stabilization to be possible by adding cement. Considerable quantities of sand or sandy loam would be needed, and might perhaps be most cheaply obtained by stripping the clay overburden to form sandpits at suitable spots. The possibilities of this method are certainly worth investigating together with those of any other that appears to offer an economical solution to the road problem of the Upper Nile.[1]

I shall now proceed to discuss in more detail a programme of road construction for the Sudan. An important general principle will be to locate the trunk roads in such a manner that they supplement rather than compete with the railways. Fortunately both the geography of the Sudan and the layout of the present railway network lend themselves to the observance of this principle. We are not primarily concerned here with short feeder roads, but rather with the skeleton of highways; the former will naturally be designed to feed both the latter and the railways.

In this article I shall make no attempt to deal with the detailed economics of road-building. That no country can be properly developed without an adequate system of roads is a proposition which few people will dispute. Those few who doubt it may, perhaps, be convinced of

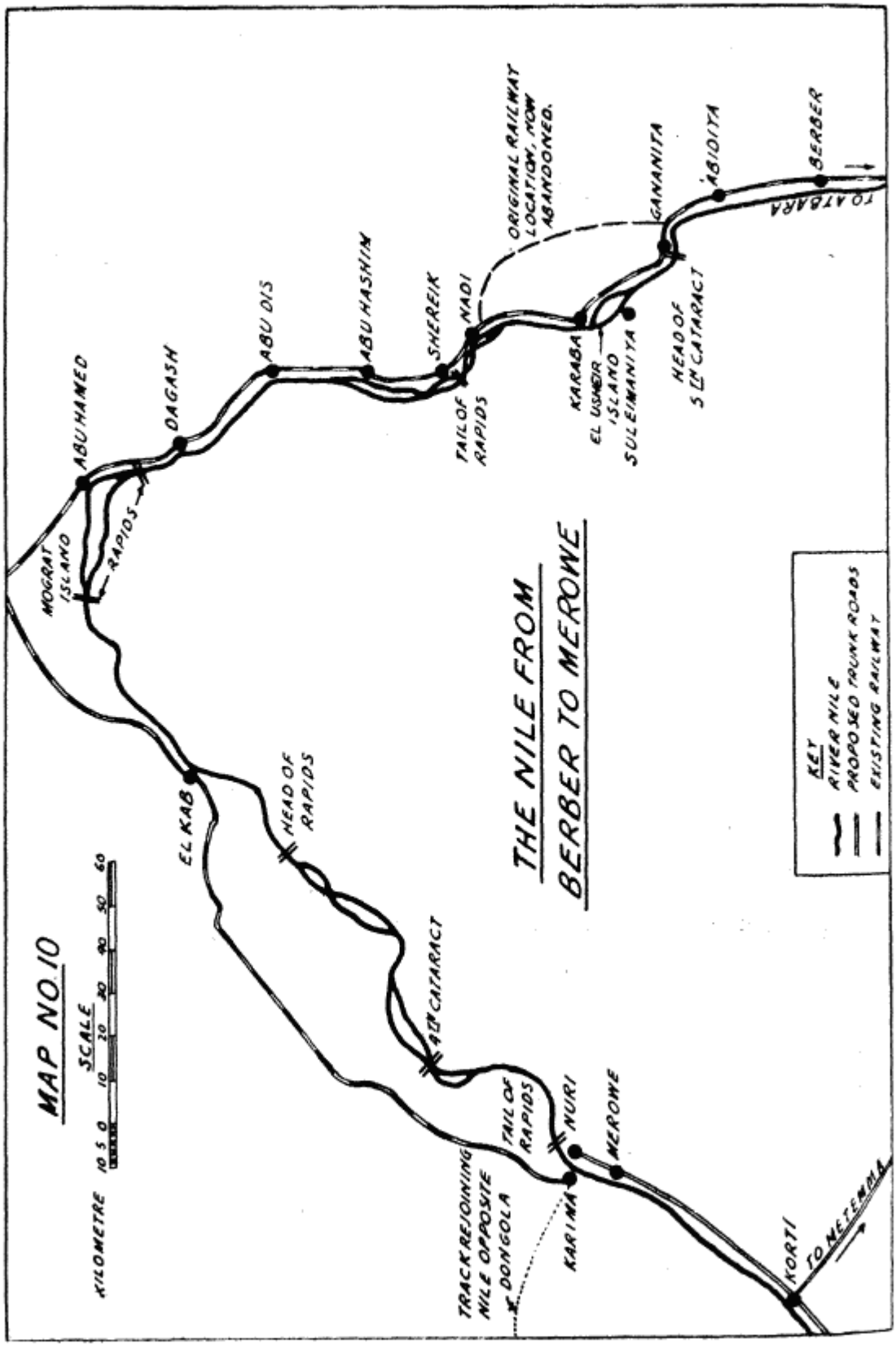
[1]Experiments are now being made elsewhere with groundnut husks.—*Ed.*

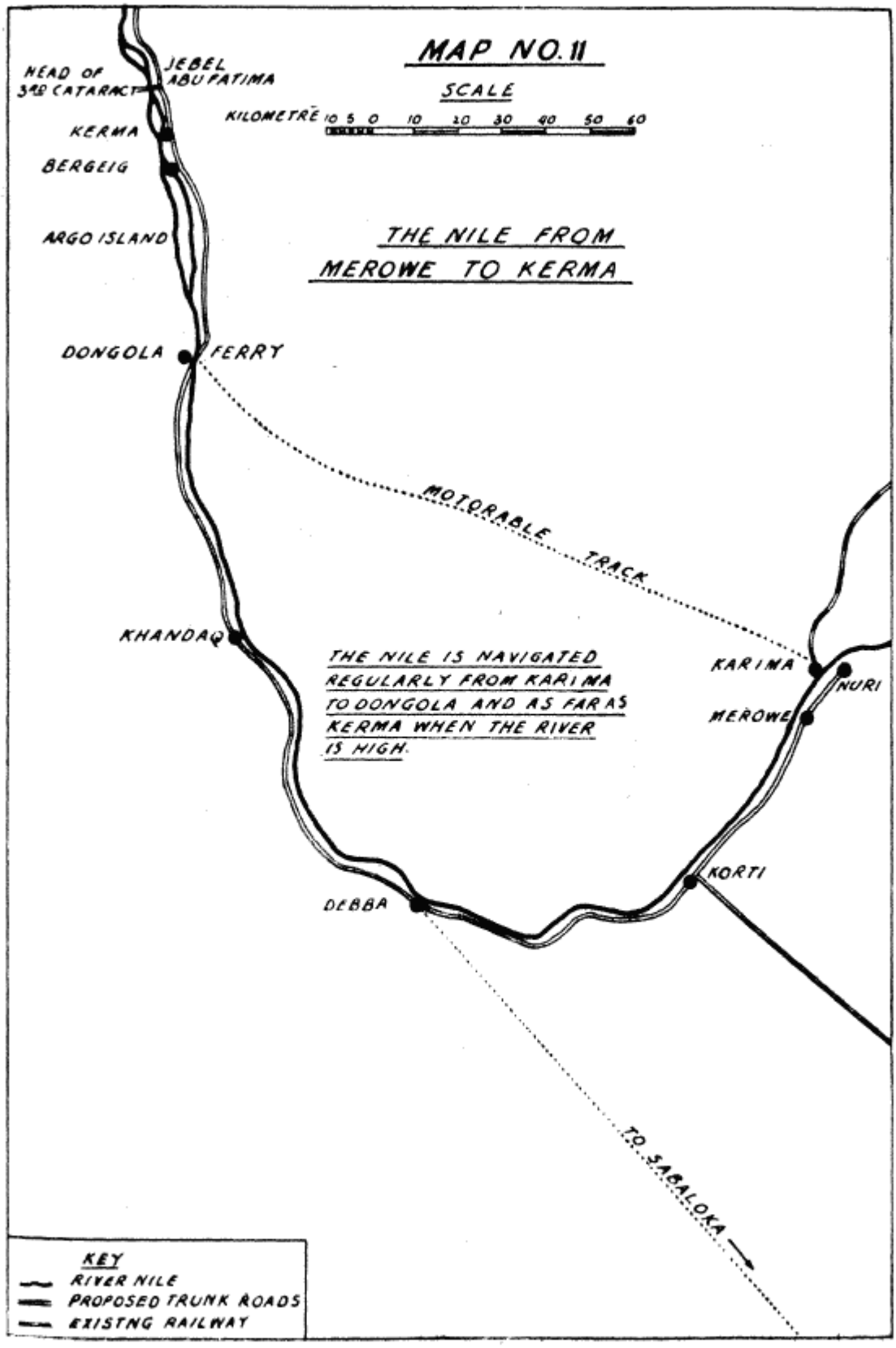
its truth by the fact that there is scarcely a civilised government in the world to-day which is not engaged in either constructing or maintaining a nation-wide system of roads. This being so the only questions for discussion are the best locations for roads, the best methods of construction, the rate at which the work is to be carried out, and the order in which it is to be done. This paper is concerned with the first two questions only. Once a skeleton plan has been accepted the rate at which it is carried out can easily be adjusted to suit the financial resources of the country. This does not mean that no road should be built until it can be shown conclusively that additional revenue sufficient to pay interest on the capital outlay will at once accrue. Such a line of argument disregards the numerous indirect benefits of good roads, upon which it is difficult or impossible to set a money value; it also makes no allowance for the well-established fact that many roads by their mere existence develop social, industrial, and administrative activities, which did not previously exist.

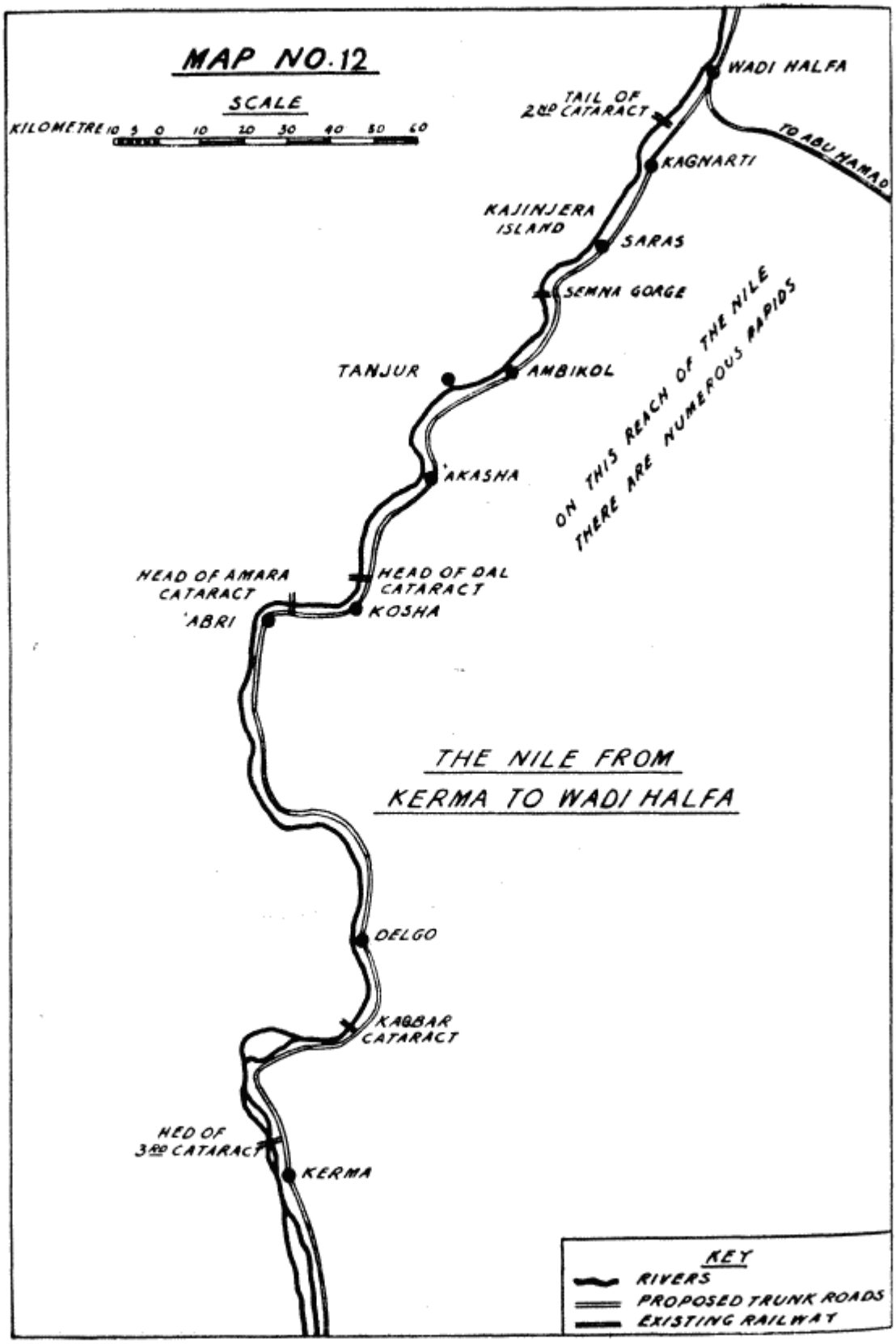
For the discussion which follows I shall give very rough estimates of probable costs. At this early stage all such figures must obviously be highly approximate; they are intended, it must be clearly understood, merely as a rough indication. In a report recently published by the Uganda Government it was estimated that to re-align a main road cost £ 1,000 per mile, and to surface it with bitumen a further £ 750 per mile. A figure of £ 1,500 per mile has therefore been taken as not unreasonable for the Sudan. Much obviously depends on the trend of world prices for such things as bitumen or road-making machinery, and no estimate made at present can hope to be accurate.

2.—Trunk Roads in the Northern Sudan. (See Maps 10, 11, 12).

The main purpose must be to provide a network that will connect Khartoum directly by road with all important towns and districts. As far as possible main roads should not parallel existing railways or navigable rivers, though a certain amount of duplication will in practice be unavoidable. We shall start by considering the most suitable location for a road to the north. As already pointed out when discussing the desert railway, there are two main routes from Khartoum to Wadi Halfa, one of which is followed by the present railway. It will therefore be natural for the new road to adopt the other and thus keep close to the left bank of the Nile as far as Dongola, except for the desert crossing between Metemma (opposite Shendi) and Korti. This location is to be preferred to that from Sabaloka to Debba direct,


MAP NO. 10
SCALE
KILOMETRE 10 5 0 10 20 30 40 50 60
THE NILE FROM
BERBER TO MEROWE
KEY
RIVER NILE
PROPOSED TRUNK ROADS
EXISTING RAILWAY
ABU HAMED
MOGRAT ISLAND
RAPIDS
DAGASH
ABU DIS
ABU HASHIM
SHEREIK
NAOI
TAIL OF RAPIDS
ORIGINAL RAILWAY LOCATION, NOW ABANDONED.
KARABA
EL USHER ISLAND
SULEIMANIYA
GANANITA
HEAD OF 5TH CATARACT
ABIDIYA
BERBER
TO ATBARA
EL KAB
HEAD OF RAPIDS
4TH CATARACT
TAIL OF RAPIDS
NURI
MEROWE
TRACK REJOINING NILE OPPOSITE DONGOLA
KARIMA
KORTI
TO NEFEMDA

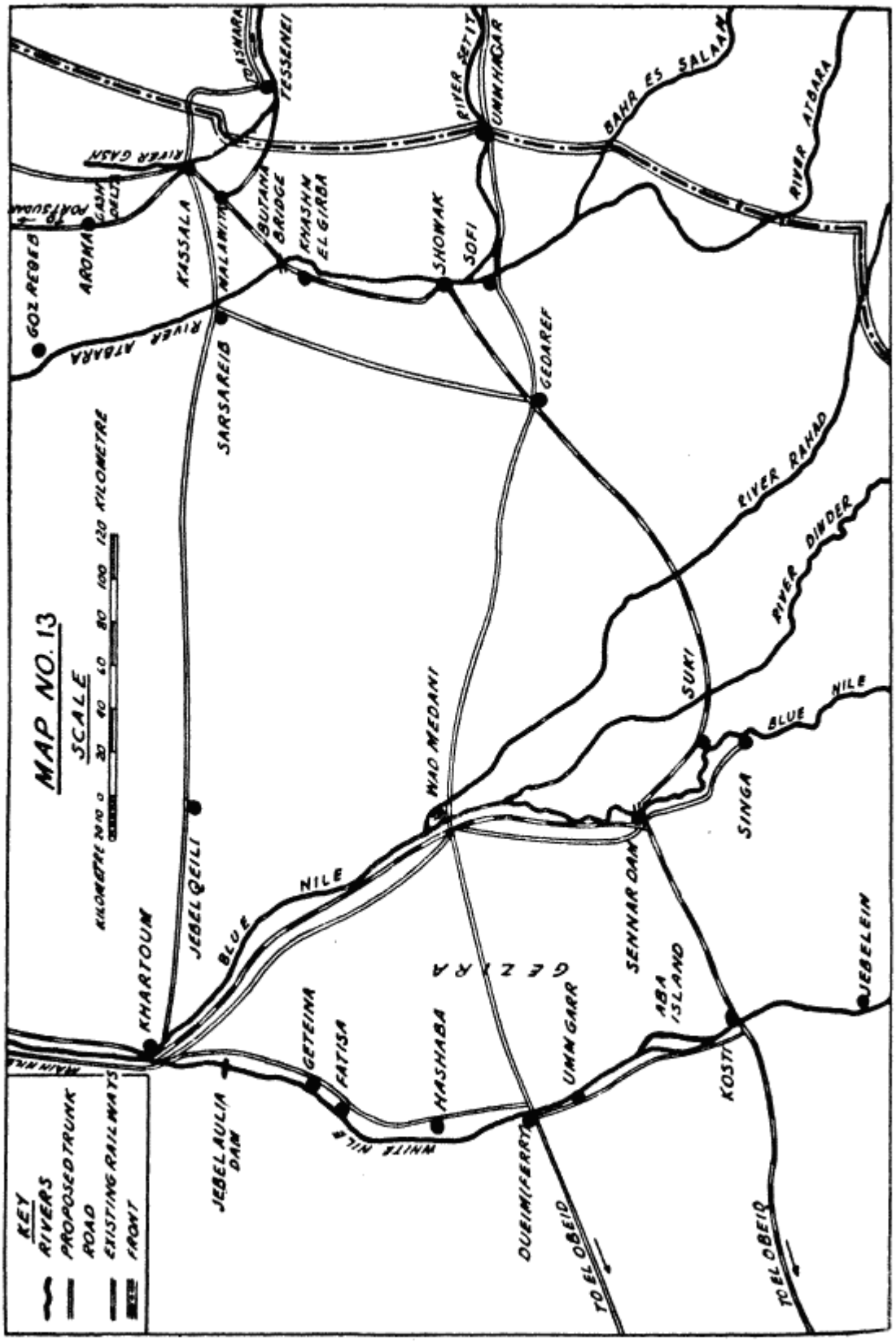

MAP NO. 11
SCALE
KILOMETRE 10 5 0 10 20 30 40 50 60
HEAD OF 3RD CATARACT
JEBEL ABU FATIMA
KERMA
BERGEIG
ARGO ISLAND
THE NILE FROM MEROWE TO KERMA
DONGOLA
FERRY
MOTORABLE TRACK
KHANDAQ
THE NILE IS NAVIGATED REGULARLY FROM KARIMA TO DONGOLA AND AS FAR AS KERMA WHEN THE RIVER IS HIGH.
KARIMA
NURI
MEROWE
KORTI
DEBBA
TO SABALOKA
KEY
RIVER NILE
PROPOSED TRUNK ROADS
EXISTNG RAILWAY

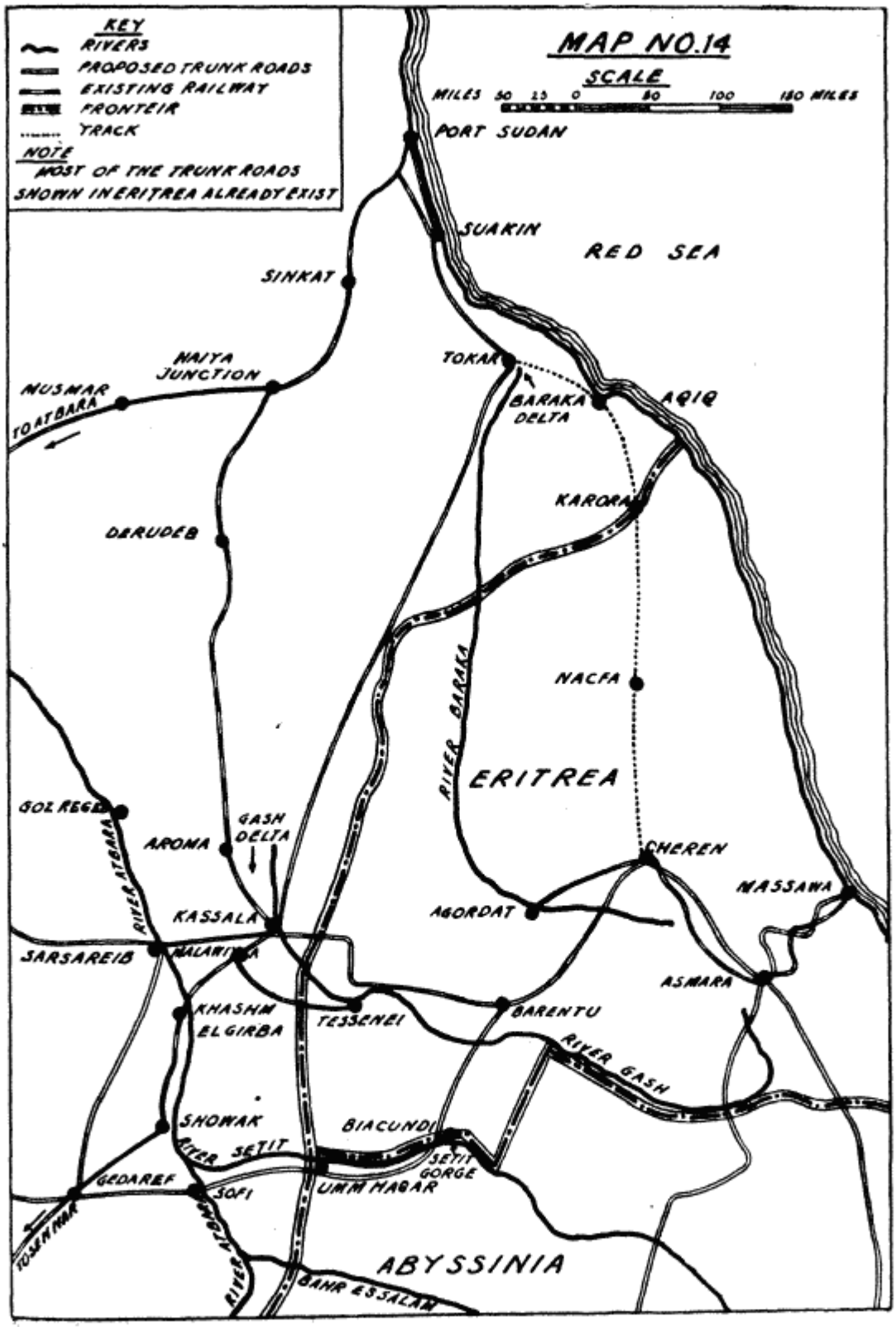

MAP NO. 12
SCALE
KILOMETRE 10 5 0 10 20 30 40 50 60
WADI HALFA
TAIL OF 2ND CATARACT
TO ABU HAMAD
KAGNARTI
KAJINJERA ISLAND
SARAS
SEMNA GORGE
ON THIS REACH OF THE NILE THERE ARE NUMEROUS RAPIDS
TANJUR
AMBIKOL
'AKASHA
HEAD OF AMARA CATARACT
'ABRI
HEAD OF DAL CATARACT
KOSHA
THE NILE FROM KERMA TO WADI HALFA
DELGO
KABBAR CATARACT
HED OF 3RD CATARACT
KERMA
KEY
RIVERS
PROPOSED TRUNK ROADS
EXISTING RAILWAY

despite its extra length, because it is desirable for the road to serve directly as many riverside villages as possible. One feeder road about 40 miles long would be required to connect Nuri and Merowe with Korti, and a second nearly 100 miles long from Metemma to Fadlab would be desirable to serve such important pumping stations as Kitiab and Zeidab. A ferry over the Nile from Fadlab to Atbara would then provide a good road connection between Khartoum and the headquarters of the Sudan Railways. The distance by road from Khartoum to Dongola through Metemma and Korti is rather under 400 miles.

The present antiquated ferry over the Nile at Dongola would be replaced by a diesel-driven vessel of modern design, and the new road would then follow the right bank of the Nile for a distance of rather over 250 miles to Wadi Halfa. In order to remain within easy reach of water and to serve the local communities, it would never diverge far from the river. For a railway an inland location may often be an advantage, but a road can accept much steeper grades and sharper curves. Moreover, it is important that a road should keep as close to water as possible in order to minimise the danger that travellers may suffer severely from, and even die of, thirst. From Wadi Halfa onwards there is no reason why the road should not be continued for a further 200 miles or so to join up with the Egyptian system at Aswan. A road from Khartoum to Wadi Halfa with branches to Atbara and Nuri would probably cost about one and a quarter million pounds with another quarter of a million for the Aswan extension, which would be located almost entirely on Egyptian soil. Perhaps the most important result of building this road would be to put the old province of Dongola on the map once more and thus to rouse it from the sleepy state into which it has relapsed since the beginning of the century.

A second trunk road would run due east from Khartoum (see Maps 13 and 14), past Jebel Qeili 90 miles out, to strike the Atbara river at Sarsareib about 30 miles below the Butana railway bridge, and continue for a further 40 miles to Kassala which is approximately 270 miles from Khartoum by this route. For most of the way the country is flat and well suited for road construction, but the Atbara constitutes a serious obstacle. Local conditions do not favour a ferry, which would be difficult to operate during the flood season owing to the violence of the current. From July to September in a normal year the Atbara could be navigated, though not without danger from uncharted rocks, as far as the Butana bridge. No regular service is now operated, but, before the Kassala railway was built, the small amount of cotton then produced in the Gash delta was exported by


MAP NO. 13
SCALE
KILOMETRE 20 0 20 40 60 80 100 120 KILOMETRE
KEY
RIVERS
PROPOSED TRUNK ROAD
EXISTING RAILWAYS
FRONT
KHARTOUM
JEBEL QEILI
SARSAREIB
KASSALA
GOZ REGEB
ARORA
GASH
RIVER GASH
RIVER ATBARA
MALAWIYA
BUTANA BRIDGE
KHASHM EL GIRBA
TESSENEI
ASHARA
SHOWAK
SOFI
GEDAREF
RIVER SETIT
UMM HAGAR
BAHR ES SALAAM
RIVER ATBARA
RIVER RAHAD
RIVER DINDER
BLUE NILE
NILE
WAD MEDANI
SUKI
SINGA
SENNAR DAM
ABA ISLAND
KOSTI
JEBELEIN
GEZIRA
GETEINA
FATISA
HASHABA
UMM GARR
DUEIM
WHITE NILE
JEBEL AULIA DAM
TO EL OBEID
TO EL OBEID


KEY
RIVERS
PROPOSED TRUNK ROADS
EXISTING RAILWAY
FRONTEIR
TRACK
NOTE
MOST OF THE TRUNK ROADS SHOWN IN ERITREA ALREADY EXIST
MAP NO.14
SCALE
MILES 50 25 0 50 100 150 MILES
PORT SUDAN
SUAKIN
RED SEA
SINKAT
TOKAR
BARAKA DELTA
AQIQ
NAIYA JUNCTION
MUSMAR
TO ATBARA
KAROra
DERUDEB
NACFA
RIVER BARKA
ERITREA
GOZ REGEB
RIVER ATBARA
AROMA
GASH DELTA
CHEREN
NASSAWA
KASSALA
AGORDAT
SARSAREIB
ASMARA
KHASHM EL GIRBA
TESSENEI
BARENTU
RIVER GASH
SHOWAK
BIACUNDI
RIVER SETIT
SETIT GORGE
GEDAREF
SOFI
UMM HAGAR
TOSEN NAM
RIVER ATBARA
ABYSSINIA
BAHR ESSALAM

barge from Sarsareib. A road bridge here would slightly limit the possibilities of navigation in future, but it is most unlikely that the Atbara will ever again be used commercially. There is very little water in the Atbara for half the year and construction of a fixed-span bridge at Sarsareib should therefore offer no great difficulties. The present railway journey from Khartoum to Kassala is very roundabout, the distance being 578 miles by Atbara and 450 by Sennar; thus the road would save at least 180 miles.

Situated at the head of the Gash Delta and at the foot of its characteristic *Jebel*, Kassala is a town whose already considerable importance is likely to increase rather than diminish. Almost alone among towns in the northern Sudan it enjoys an ample supply of underground water not far below the surface, and it also benefits from the Gash Irrigation Scheme. Moreover, lying less than 20 miles west of the Italian roadhead on the frontier, it is the natural gateway to Eritrea. It is 260 miles from Asmara to Kassala, which would thus be almost exactly half way between Asmara and Khartoum. The best way to connect Port Sudan with the rest of the country by road would probably be through Kassala. The length of such a road would be rather over 300 miles, and consequently Port Sudan would be nearly 100 miles further from Khartoum by road than by rail. On the other hand, a highway from Kassala to the Red Sea coast would serve directly the Gash Irrigation Scheme, and indirectly both the Tokar Irrigation Scheme and the hill station of Erkowit. At one time a telegraph line followed approximately the route now suggested for a trunk road, and vehicles have on occasion been driven through. For most of the way, however, the country is hilly, and therefore a good road is likely to be fairly expensive.

If a road were built as suggested above the result would probably be to turn Kassala into an important centre with highways diverging to Khartoum, Asmara, and Port Sudan. A demand for a good hotel could be expected to arise, and there would be a strong inducement to improve the appearance of the town by paving the streets and taking advantage of the underground water supplies to line them with trees. At the same time every effort should be made to abate as far as possible the dust nuisance which has in the past earned for Kassala an unenviable notoriety. The *Jebel* and the river Gash between them confer a certain amount of character on the town which could be made quite attractive, especially now that the long-awaited bridge over the Gash has at last been built.

The Gezira Irrigation Scheme is the economic heart of the Sudan,

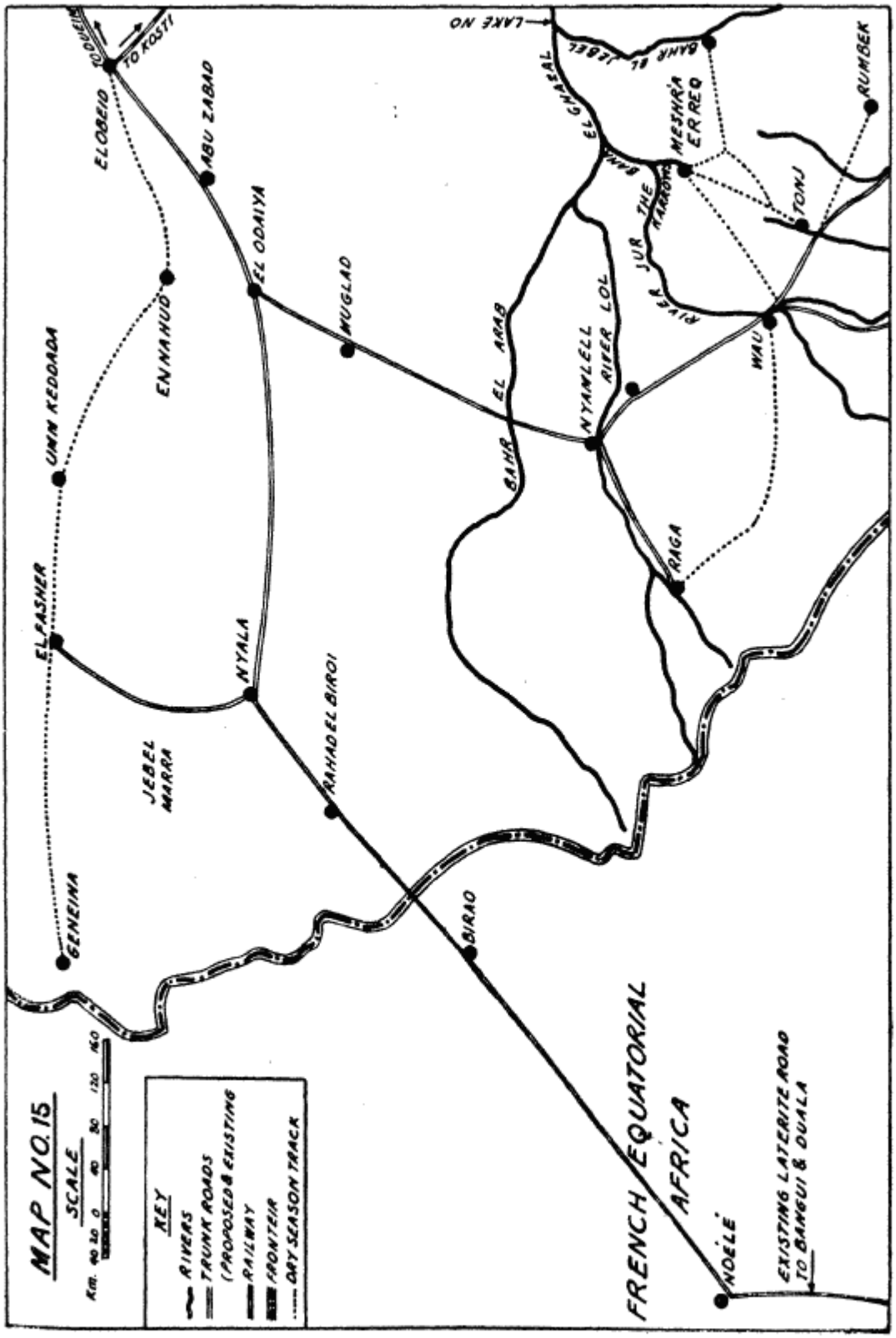
and there is an evident need for a good road from Khartoum to its centre of administration at Wad Medani. The heavy clay soil on which cotton is grown is not suitable for building roads, but a location could be found such that sand was never far away. An extension 60 miles long to Sennar and perhaps 40 miles further to Singa would probably be desirable, but would not form an internal part of the trunk road system here proposed. Beyond Wad Medani the main road would be continued eastwards to Gedaref with ferries across the Blue Nile and Rahad, later to be replaced by bridges. With the development of mechanical crop production the importance of Gedaref should steadily increase, and a good direct road through Wad Medani to Khartoum would be a great advantage. The total distance would be only about 250 miles compared with 315 by rail; Wad Medani is about 110 miles from Khartoum by either road or rail.

If one disregarded international frontiers and considered only local geography, the best continuation from Gedaref would be a road about 200 miles long that would follow the Setit valley as far as Biacundi and then turn northwards to meet the main road from Asmara to Tessenei and Kassala at Barentu, just over 150 miles from Asmara. Such a route would cross the Atbara a few miles above its confluence with the Setit and some 35 east of Gedaref at Sofi, where Sir Samuel Baker spent the rainy season of 1861. It would then follow the valley of the Setit past Umm Hagar, a village 90 miles from Gedaref where the Sudan, Eritrea, and Ethiopia meet, to Biacundi, 50 miles further east. Immediately above this point the Setit threads its way through a remarkable gorge about 3 miles long which is said by the Italians to be at one point only a few feet wide; presumably this would be an excellent site for a bridge to carry the road across to the north bank of the river. The distance from Biacundi to Barentu is about 65 miles; just over half way the road would pass the gold mine that the Italians exploited, and 24 miles from Barentu it would cross the Mareb or upper Gash river which here flows in a rocky gorge and is easily bridged. Probably it would be convenient to use the abutments of the old single-span steel truss which was destroyed by the retreating Italians in 1941. The proposed road from Gedaref to Barentu would open up the little-known Setit valley and might well attract an appreciable number of tourists.[1] To connect Gedaref with Kassala and Port Sudan a direct road to Sarsareib would be desirable; the distance is just under 100 miles, and it would join the main road from Khartoum to Kassala just west of the bridge over the Atbara.

[1] See *The Western Bassopiano District of Eritrea* by P. H. Soar *Geog. Jour.* CXIV, pp. 233-6, (1949).—*Ed.*

The main trunk road from Khartoum to the west could conveniently follow the east bank of the White Nile for about 130 miles to Ed Dueim on the west bank which would be reached by ferry. In this way it would serve directly the dam at Jebel Aulia, the town of Geteina, and the large government pumping stations at Fatisa and Hashaba. A road on the other bank could cross the White Nile by either the Omdurman bridge or the Jebel Aulia dam, but it would then traverse comparatively empty country. Moreover, a ferry is needed at Ed Dueim anyhow for the important 100-mile road to Wad Medani which would serve part of the Gezira and provide a useful direct connection between Kordofan and the east. The road would then strike out westwards across the desert to El Obeid, which would be about 300 miles from Khartoum by this route compared with 428 by railway and approximately 230 by air. It will probably be desirable to build a road 70 miles long from Ed Dueim to Kosti; the main object would be to serve the numerous pumping stations on this reach, especially Umm Gerr and Aba Island, but a direct road from Khartoum to Kosti would also be useful. With the construction of these roads Ed Dueim would be provided with a reasonable system of communications such as it now most conspicuously lacks, being reduced during the rains to a river service that is slow, infrequent, and uncertain. As the natural centre for several large pumping stations and with the new educational institute of Bakht er Ruda just outside, Ed Dueim can be expected to develop steadily once it becomes reasonably accessible.

There should be no need to stress the importance of El Obeid as the commercial and administrative centre of the province of Kordofan which can hardly fail to benefit from a direct all-weather road to Khartoum (see Map 15). On the assumption that the El Fasher railway will eventually follow approximately the line of the existing track through Nahud and Umm Kedada, it will probably be best to locate the road further south so that it passes through Nyala. Such a route has the important advantage that it can conveniently be connected with the laterite road systems of the southern Sudan and French Equatorial Africa. The best way of achieving the first objective will be discussed later. The link with French Equatorial Africa demands a road some 400 miles long from Nyala to Ndélé, of which about 150 miles would be in the Sudan. Apart from one or two long river crossings on French territory the going is easy throughout and laterite is plentiful. Nyala itself lies about 400 miles west of El Obeid and 120 south of El Fasher. A road from Nyala to El Fasher could conveniently be diverted slightly to serve the important district of Jebel Marra, and might then be about 150 miles long.


MAP NO. 15
SCALE
KEY
RIVERS
TRUNK ROADS (PROPOSED & EXISTING
RAILWAY
FRONTIER
DRY SEASON TRACK
TO ROSEIRES
TO KOSTI
ELOBEID
ABU ZABAD
EL ODAIYA
ENNAHUD
UMM KEDDADA
EL FASHER
NYALA
JEBEL MARRA
WUGLAD
RAHAD EL BIRDI
EL ARAB
BAHR
NYAMLELL
RIVER LOL
EL GHAZAL
LAKE NO
BAHR EL JEBEL
BAHR
RIVER JUR
MESHRA ER REQ
TONJ
WAU
RAGA
RUMBEK
BIRAO
FRENCH EQUATORIAL AFRICA
NOELE
EXISTING LATERITE ROAD TO BANGUI & DUALA

The Nuba Mountains district is a region that certainly ought to be connected to the main road system of the Sudan. A road for this purpose can conveniently be prolonged to reach the left bank of the White Nile opposite Malakal, which would thus be accessible by land at all seasons. A road from El Obeid to Malakal by Kadugli and Talodi would be nearly 400 miles long and should serve to facilitate the development of an important part of the country.

The road system for the northern Sudan which has just been outlined may be summarized as follows :—

	Approximate Length in Miles	*Approximate Cost in* L.E.
From Khartoum to Wadi Halfa with branches to Nuri and Atbara	800	1,200,000
From Khartoum *via* Kassala to Port Sudan with a branch to Sabderat	600	1,000,000
From Khartoum *via* Wad Medani to Gedaref with branches to Singa and Sarsareib ..	450	700,000
From Khartoum *via* Ed Dueim to El Obeid with a branch to Wad Medani ..	400	600,000
From El Obeid to Nyala and the frontier with a branch to El Fasher *via* Jebel Marra	700	1,100,000
From El Obeid *via* Kadugli and Talodi to Malakal	400	600,000
From Wadi Halfa to Aswan (mostly in Egypt)	200	300,000
From Gedaref *via* the Setit valley to Barentu (more than half in Eritrea)	200	300,000
TOTALS	3,750	5,800,000

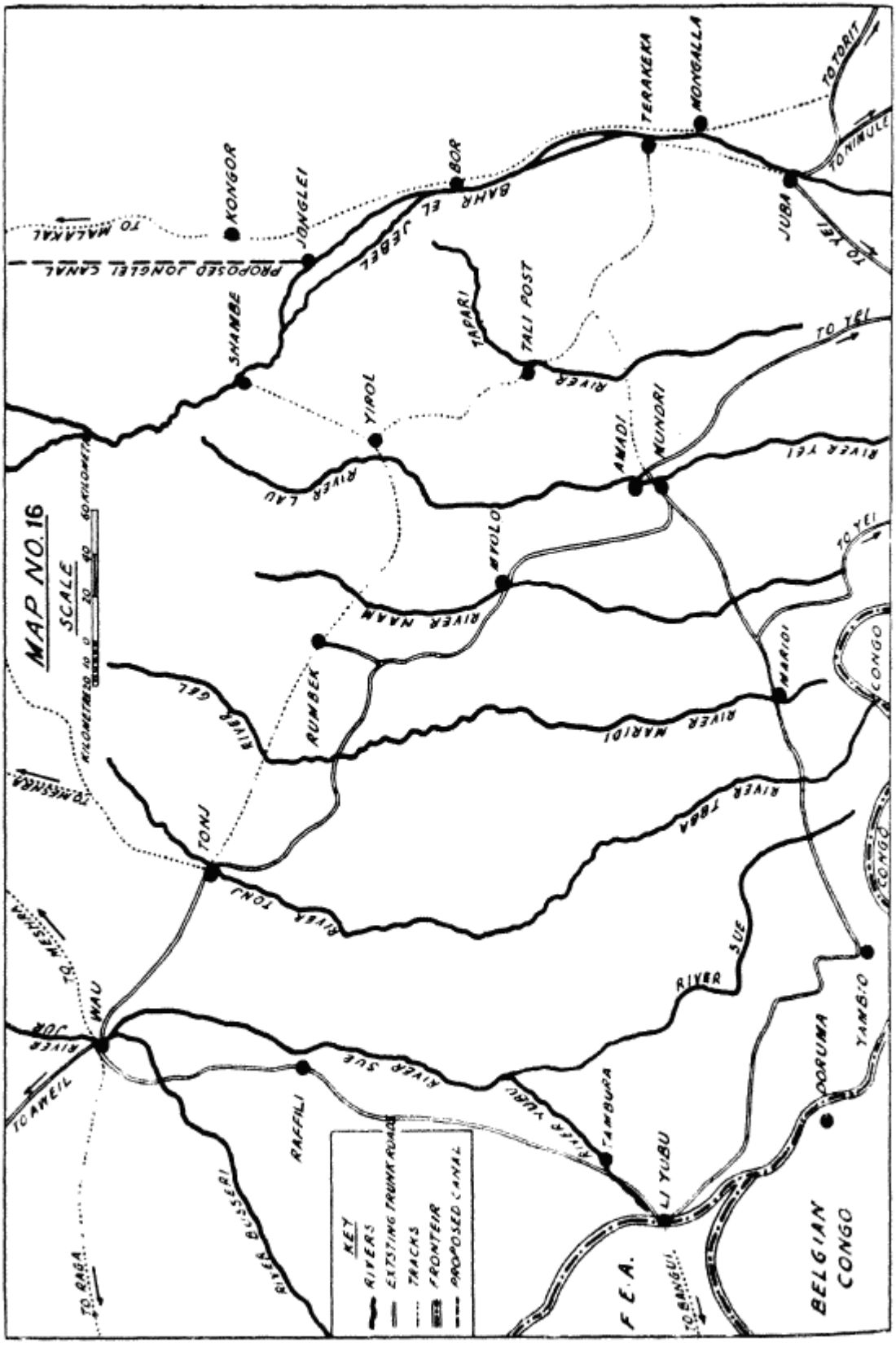
These figures are necessarily quite approximate, especially the estimated costs; nevertheless they will give some idea of the magnitude of the work proposed. In order to carry out the work efficiently it will be most important to decide at what rate the roads are to be built and then to develop an organization designed to work steadily at

that rate. Every effort should be made to avoid changing this rate abruptly, for sudden variations make efficient use of men and materials almost impossible.

3.—Trunk Roads in the Southern Sudan. (See Map 16).

In this section we shall be concerned with that part of the Sudan which lies south of the twelfth parallel. As already remarked much of this area is provided with a reasonably adequate network of good laterite roads, of which the most important lie west of the Bahr el Jebel. The main road from Juba to Wau through Tonj is just under 500 miles long ; spurs 8 and 25 miles long serve Amadi and Rumbek respectively. Southwards from Wau the road follows the valley of the Sue and its tributary the Yubu for about 200 miles through Tambura to Li Yubu on the French frontier. Here it turns to the east and roughly parallels the southern frontier of the Sudan, passing through Yambio after 130 miles and Maridi 90 miles further on. From this point there are two ways back to Juba each about 240 miles long ; one leads back to the Wau road near Amadi and the other to Yei, a town 100 miles from Juba and 40 from the frontier at Aba on the main road to the Belgian Congo. The foregoing road system consists essentially of a loop with one cross-connection and several spurs, the total length being about 1,300 miles. We shall now consider how it is or could be connected with the outer world.

The most serious defect of the Juba-Wau road systems, is that there is at present no all-weather connection with any intermediate river port. The four points at which such a connection might be made are Terakeka, Shambe, Adok, and Meshra er Req. The first of these is only 46 river miles below Juba, but it has the advantage of being easily accessible for steamers at all stages of the river and of being the nearest river port to Yambio ; on the other hand the road from Amadi is not always open during the rains. Moreover, Terakeka itself is a port only in the sense that river craft can conveniently tie up alongside the bank ; there is no wharf and no sort of equipment for handling cargo. Shambe has a small wharf, but lies on a lagoon which cannot be navigated by large river craft at low water. It is 45 miles by road from Yirol and 115 from Rumbek ; although laterite is to be found near Yirol and elsewhere it would be an expensive matter to make this road passable at all seasons. The reason is that it has to cross the flood plains of both the Naam and the Lau, the latter being very wide. When the Jonglei Canal has been built, Shambe will probably become even less


MAP NO. 16
SCALE
KILOMETERS
KONGOR
JONGLEI
BOR
TERAKEKA
MONGALLA
TO TORIT
TO NIMULE
JUBA
TO YEI
PROPOSED JONGLEI CANAL
TO MALAKAL
SHAMBE
BAHR EL JEBEL
TAFARI
TALI POST
RIVER
TO YEI
YIROL
AMADI
MUNDRI
RIVER YEI
RIVER LAU
TOLO
RIVER NAAM
TO YEI
RUMBEK
MARIDI
CONGO
RIVER MARIDI
TONJ
RIVER TOBA
TO MESHRA
RIVER TONJ
RIVER SUE
WAU
TO WESTERN
RIVER JUR
TO AMEIL
RAFFILI
RIVER SUE
RIVER YUBU
TAMBURA
LI YUBU
DORUMA
YAMBIO
BELGIAN CONGO
F.E.A.
TO BANGUI
TO RAGA
RIVER BUSSERI
KEY
RIVERS
EXISTING TARMAC ROAD
TRACKS
FRONTEIR
PROPOSED CANAL

satisfactory as a port than it now is and will no longer lie on the main transport route. To spend money on improving the Rumbek-Shambe road is therefore a policy of doubtful wisdom, for with the Jonglei Canal open the best scheme would probably be to build a good road from Rumbek through Yirol to Jonglei itself which would then replace Shambe as a river port.

It has recently become possible, though far from easy, to motor during the dry season from Tonj to Adok, a distance of about 180 miles. The track is on clay soil for most of the way, and the cost of converting it into a road would certainly be prohibitive. A road from Wau, or possibly from Tonj, to Meshra er Req has often been discussed and has certain obvious advantages; it would be about 110 miles long. The main trouble is that the port of Meshra is not always accessible either for lack of water or on account of floating vegetation. Nevertheless a good road from Wau to Meshra would enormously improve communications in that part of the world and hence facilitate its development. The Jur river service to Wau operates in a normal year for only three months and even then it is limited by the difficulty of navigating the Narrows; a comparatively secure alternative outlet through Meshra is therefore much to be desired.

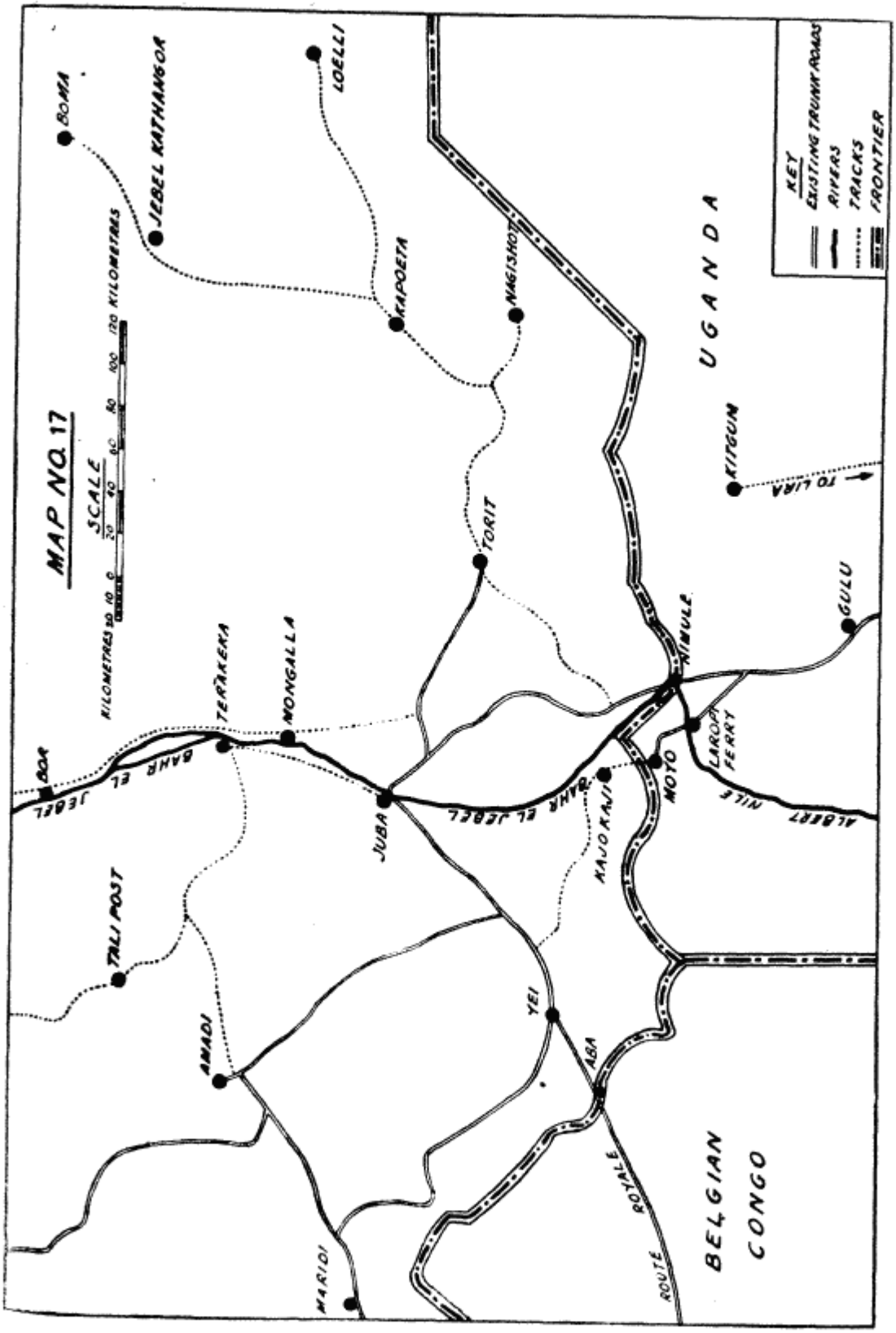
From Wau there is a road through Aweil to Nyamlell, 140 miles to the north-west. It could be continued through Muglad to El Odaiya on the proposed road from El Obeid to Nyala. Such a link would be about 250 miles long, and would probably constitute the most convenient way of connecting the north Sudan with the south by road. The distance from Wau to El Obeid by this route would be about 600 miles. and from Juba to Khartoum about 1,400 compared with 1,100 by river and about 900 by road through the Upper Nile province. The isolated district headquarters of Raga could conveniently be connected to the general network by means of a road about 100 miles long from Nyamlell; another possibility would be to rebuild the present track 200 miles long which connects Raga directly with Wau. The territory west of Raga is almost uninhabited, and consequently Li Yubu on the frontier is the only convenient point of access to French Equatorial Africa. The distance westwards to Bangui is about 800 miles; for the last half, west of Bangassou, the road is probably quite good, and cars have been driven right through in the dry season without much difficulty.

The only good surface connection with the Belgian Congo is through Aba, where the road from Juba connects with what is known as the Route Royale. This important highway starts from the river port of Bumba on the right bank of the Congo some 20 miles below the

Itimbiri confluence and runs due east for about 700 miles to the Sudan frontier. The Belgian mission station and district headquarters of Doruma is connected by a branch 150 miles long with the Route Royale some 215 miles from Bumba. It lies only 20 miles south of the Li Yubu-Yambio road and a properly built branch appears to be desirable. Some 15 miles east of Yei and 85 from Juba a road 95 miles long branches off to Kajo-Kaji, the centre of the Kuku country. From here it is only about 20 miles by road to Moyo in Uganda, from which point a road leads down to the Nile ferry at Laropi and finally to Gulu. The road in the Sudan, though well provided with bridges, is probably not passable during the rains and ought perhaps to be classified as a track rather than a road.

We now turn to that part of Equatoria province which lies east of the Bahr el Jebel (Map No. 17). From the eastern terminus of the ferry over this river at Juba an excellent road leads direct to Nimule and Uganda ; it has already been mentioned when discussing the Uganda railway, and there is nothing more to be said here. About 16 miles out a road branches eastwards to Torit, a district headquarters on the Kinyeti river 85 miles from Juba. Nearly 70 miles further on and some distance after the bridge over the Kidepo river, a branch nearly 30 miles long leads up to Nagishot which lies in the Dongotona Hills at an altitude of about 6,500 feet above sea level. The climb is stiff, but considering the limited means available to build it the road is an excellent piece of work. What is needed to preserve it from damage by rain is a proper surface, good ditches, and a number of culverts at the re-entrant angles ; if these were provided access to Nagishot would be quite easy and the place could be developed as a hill station to take full advantage of its excellent climate. After the Nagishot branch diverges, the main road continues to Kapoeta in the Toposa country about 200 miles from Juba. Throughout this distance it runs between the mountains on the Uganda frontier and the flat clay plains of the Upper Nile region, and crosses a number of rivers which lose themselves in those plains. Bridges are adequate on the whole, but culverts, though numerous, are often too lightly built with the result that their headwalls tend to overturn. The surface leaves a good deal to be desired, particularly east of Torit, and altogether a considerable amount of work would be required to bring this road up to a satisfactory standard.

Beyond Kapoeta there is a track 140 miles long to the Boma Plateau ; for about 90 miles to Jebel Kathangor the soil is fairly sandy, but after that the track crosses a clay plain 25 miles wide. After wandering through the foothills it finally climbs steeply up the side of


MAP NO 17
SCALE
KILOMETRES 20 0 20 40 60 80 100 120 KILOMETRES
KEY
EXISTING TRUNK ROADS
RIVERS
TRACKS
FRONTIER
BOMA
JEBEL KATHANGOR
LOELLI
KAPOETA
NADISHOT
TORIT
KITGUM
TO LIRA
UGANDA
GULU
NIMULE
LAROPI FERRY
NILE
ALBERT
MOYO
KAJOKAJI
BAHR EL JEBEL
JUBA
MONGALLA
TERAKEKA
DOR
BAHR EL JEBEL
TALI POST
AMADI
YEI
ABA
ROYALE
ROUTE
MAVOI
BELGIAN CONGO

the escarpment onto the plateau. Except in the neighbourhood of Kapoeta the country is very sparsely populated, and the only purpose of the existing track is to supply the small military garrison of the Boma Plateau. At certain periods of the year the country traversed by this track is the scene of migrations of game on a remarkable scale. Immense numbers of buck and other animals trek northwards to the plains or southwards from them according to the season ; by all accounts the sight is most extraordinary and it seems quite possible that tourists could be attracted. The idea would be to build a good road as far as necessary and provide some simple but comfortable rest house accommodation, perhaps near Jebel Kathangor, during the period of mass migration. The use of firearms would, of course, be strictly prohibited. Although, before the construction of the present road by Gulu, all vehicles used the track from Torit to Soroti by Kitgum and Lira, the country south of the Uganda frontier does not justify the construction of any road across the border east of Nimule.

To complete our circuit of the Sudan we now have to consider the great clay plains of the Upper Nile province. For reasons already explained it will be prohibitively expensive to build good all-weather roads in the area in any foreseeable future. There is no reason, however, why improved and properly graded tracks should not be available in the dry season, for banks can be built high enough to prevent their being submerged even during that period as now happens on occasion. The layout of these tracks will naturally be determined almost entirely by reasons of administrative convenience, and the details need not concern us here. They will include a main road from Juba through Bor to Malakal and thence northwards to connect finally with the trunk roads of the Gezira. This will provide during the dry season a direct road connecting Juba with Khartoum, but at other times of the year traffic will have to take the roundabout route through Wau and El Obeid.

PART IV.—RIVERS IN THE NORTH.

1.—Multiple Purpose Development.

The present 500-mile rail haul from Khartoum to Port Sudan strangles the agricultural development of this country, because only very few crops can stand the freight charge and still be sold on the

world market at an economic price. Cotton is, for this reason, the only cash crop of importance that is grown on the Gezira Irrigation Scheme, and any attempt to develop the non-agricultural resources of the country is faced with this basic difficulty. The result is that the Sudan has almost all her eggs in one basket and will find herself in a parlous condition if cotton prices slump. It is difficult to suggest how this state of affairs can be remedied unless cheaper transport is provided, and cheap transport over hundreds of miles means in practice water transport. If it were possible to develop the Nile between Khartoum and Wadi Halfa as a continuously navigable waterway, the problem would be solved, provided only that interest charges on capital expended were not excessive. With a navigable Nile goods could be loaded at any river port from Juba northwards into self-propelled barges which could then carry them to the Mediterranean without a single transhipment. There would be no expensive overland freight charges, and the future development of the Sudan would be immensely facilitated.

This rosy picture depends, however, on the essential proviso that interest charges on capital are not excessive. Now they undoubtedly would be excessive if the entire cost of developing the Nile were charged against navigation. The tacit assumption that it must be so charged presumably explains why no serious attempt has yet been made to devise a plan for developing the Nile as a continuously navigable waterway. Such an assumption implies that there is no other purpose for which the Nile can be developed between Khartoum and Wadi Halfa, or at least none which can bear an appreciable part of the capital cost. The facts, however, are quite otherwise. By general agreement the primary purpose of developing the main Nile must be to provide Egypt with a sufficient supply of stored water for irrigation to meet her reasonable needs. Recent surveys have disclosed two possible sites for storage dams, one at the foot of the Fourth Cataract and another near the Dal Cataract. The second purpose must be to protect Egypt and part of the northern Sudan against damage from exceptionally high floods. This can be done by cutting off the crest of such a flood and either storing it behind a dam or escaping it into some convenient depression.

Thus Navigation, so far from being the main object of developing the Nile, must be merely the third purpose, ranking after Irrigation and Flood Protection. Moreover, the needs of Navigation cannot be allowed to interfere seriously with the first two purposes. In these circumstances it is evident that Navigation cannot fairly be charged with more than a quite moderate proportion of the total capital

cost of developing the Nile. Owing to the overriding importance of irrigation it will not be possible to make the Nile continuously navigable from Khartoum to Wadi Halfa at all seasons of the year. Stored water is normally required in Egypt from February onwards, and must be released at correspondingly earlier dates from reservoirs upstream. This definitely limits the period during which navigation levels can be maintained, and they cannot be established again until the following flood comes down in July. Thus we can expect to keep the river open for navigation throughout its length only for the six-month period from August to January inclusive. With this reservation, however, there is no good reason why the development of the Nile between Khartoum and Wadi Halfa for the purposes of irrigation and flood protection should not be combined with a scheme to render it navigable.

When a river is developed for several distinct purposes the capital cost of the work ought to be divided between the various purposes. So much is clear, but the difficulty is to decide the proportion to be allocated to each. This problem is inseparable from any multiple-purpose development; in the U.S.A. it has given rise to prolonged controversies concerning the activities of the Tennessee Valley Authority. The main purposes in this case are Navigation, Power Development, and Flood Control; Irrigation is not included and Navigation has priority, but the principles governing allocation are fundamentally the same. They are discussed at length in *The Tennessee Valley Authority* by J. S. Ransmeier, published in 1942 by the Vanderbilt University Press, Nashville, Tennessee. The author reaches the conclusion that none of the methods for allocation so far proposed can be considered satisfactory either in theory or in practice; it follows that the total cost must be divided up in some more or less arbitrary manner. In any particular case, however, there is no reason why an allocation should not be agreed upon, provided always that the problem is approached in the right spirit. Whether Navigation would be able to bear the burden of such an allocation from the cost of Nile development is a question that cannot be answered until a plan has been worked out in some detail. For this reason there is no time to lose; such a plan should be drawn up as soon as possible.

2.—The Cataracts of the Nile. (See Maps 10, 11, 12 and 13).

We shall now give a brief description of the principal obstacles to navigation on the Nile between Khartoum and Wadi Halfa. It is

customary to refer to six numbered cataracts on the Nile north of Khartoum, but it must not be therefore supposed that no others exist. This nomenclature is, in fact, confusing, and would be better avoided were it not sanctioned by long-established custom. The first obstacle north of Khartoum occurs at the Sabaloka gorge, often called the Sixth Cataract. The gorge starts about 80 kilometres north of the capital and is approximately 12 kilometres long with an average width of 300 metres or so. It is, however, so deep that the slope at low water is only about 6 cms./km.; but when the flood comes down the slope increases considerably and a strong current races through the gorge. Owing to the innumerable islands navigation is not possible at low water. Sabaloka is definitely a gorge rather than a cataract and should preferably be so described; it is cut through felsite and the geological formation is remarkable.

The next obstacle begins below Abidiya about 45 kilometres north of Berber or just over 400 from Khartoum; it is known as the Fifth Cataract. In the next 20 kilometres or so the river drops about 8 metres with a slope of approximately 40 cms/km. and is quite unnavigable at low water. There are numerous islands on this reach, the largest being Draka situated near the left-bank village of Suleimaniya. An excellent view of this cataract can be obtained from the train between the stations of Gananita and Karaba; this part of the railway has been relocated, the original line having swung inland between Nadi and Abidiya. Churchill records that, in October 1897, the gunboats "plied, though with some difficulty, up and down the Fifth Cataract."

After some 40 kilometres of open water there is another rapid about 15 kilometres long which ends near Shereik, roughly 120 kilometres by river from Berber and 480 from Khartoum. This rapid is navigable at high Nile; but in December 1897, with railhead at Dagash just south of Abu Hamed, portages were necessary both here and at the Fifth Cataract in order to supply the garrison at Berber. There is open water from Shereik to Abu Hamed, a distance of about 100 kilometres. Between Khartoum and Abu Hamed the Nile drops approximately 65 metres in 580 kilometres; of this fall 30 metres occur between Khartoum and the Atbara confluence, a distance of 326 kilometres, and 25 between Berber and Shereik.

At Abu Hamed the Nile is divided into two parts by the island of Mograt, which is about 30 kilometres long and 5 broad. The rapids here are some 27 kilometres long and involve a drop of about 18 metres; navigation is impossible at low water but possible with some difficulty when the Nile is in flood. It will be noticed that this cataract, though

unnumbered, is at least as serious an obstacle as the Fifth Cataract. There follow 100 kilometres of open water to Shirri Island, where the rapids start again and continue for a further 100 kilometres to end just above Karima about 805 kilometres from Khartoum. The total fall in this series of rapids is 33 metres; of these 14 are concentrated in the Fourth Cataract which begins about 750 kilometres from Khartoum and is approximately 8 kilometres long. The Fourth Cataract shares with the Second the distinction of being the most serious obstacle to navigating the Nile north of Khartoum. There is enough water for vessels to pass only when the Nile is high, and then the current is so strong that they cannot ascend under their own power. Early in August 1897 a gunboat capsized when attempting the upstream passage with the aid of 700 men on tow ropes; later in the same month six other vessels were successfully hauled up the Fourth Cataract, but the operation was far from easy. For the ordinary purposes of commerce the Fourth Cataract is certainly not navigable.

Between Khartoum and Merowe, a distance of about 820 kilometres, the Nile drops approximately 130 metres; half of this drop occurs in the 240 kilometres which separate Merowe from Abu Hamed. Below Merowe there is no serious obstacle to navigation for about 330 kilometres until Jebel Abu Fātima marks the start of the Third Cataract 1,150 kilometres from Khartoum. This reach is navigated regularly for 270 kilometres to the town of Dongola, and during about seven months of the year for some 60 kilometres further to Kerma. The total drop between Merowe and the head of the Third Cataract is about 27 metres. When the Nile is low shifting sand banks often make navigation difficult; when it is in flood care must be taken to avoid isolated rocks.

The Third, or Hannek, Cataract is rather over 20 kilometres long with a total drop at low water of about 11 metres. The first 5 kilometres constitute the most serious obstacle and make the cataract impassable at low water; at high Nile, however, vessels can ascend without much difficulty under their own power. In the 200 kilometres below Abu Fātima there are only two other cataracts, and both are easily navigated at high Nile. The first is the Kaibar Cataract, which consists of a single granite dike about 400 metres wide and is thus the shortest obstacle between Khartoum and Wadi Halfa. At low water it acts as a dam and produces an afflux of about 3 metres; the site is about 20 kilometres south of Delgo just below the point where the Nile changes its course from east to north. After 100 kilometres of open water comes the Amāra Cataract near Abri; though nearly 10 kilometres long, it is not a serious obstacle, for the total fall at low water is barely 3 metres.

Two hundred kilometres below Jebel Abu Fātima and 1,350 from Khartoum, we reach Kosha near the head of the Dal Cataract; it was here that, for a few months during the flood of 1896, supplies for the force that occupied Dongola were transferred from rail to river. For the next 150 kilometres the Nile is little more than a succession of rapids culminating in the Second Cataract just above Wadi Halfa. The Dal Cataract itself drops 12 metres in about 24 kilometres; it is divided into two parts and Akasha lies near the head of the second. The Tanjur Cataract starts about 100 kilometres above Wadi Halfa and is approximately 12 kilometres long; the drop is nearly 10 metres overall and 7 in the last 7 kilometres. Fifteen kilometres downstream, the Ambigol Cataract has practically the same dimensions as Tanjur. The rapids of the Semna gorge are 65 kilometres from Wadi Halfa and about 3 kilometres long; the site is interesting because hieroglyphic inscriptions have been found there which appear to show that modern flood levels are about 8 metres lower than they were in antiquity. At Kajinjera Island, 55 kilometres from Wadi Halfa, there is a small rapid with a drop of nearly 5 metres, and then we reach the head of the Second Cataract.

Between Merowe and Wadi Halfa the total drop is about 125 metres; of this, 98 metres occurs below the head of the Third Cataract, and 66 below the head of the Dal Cataract. The drop in the Second Cataract varies in a normal year from 16 metres at low water to 20 at high. Being only some 14 kilometres long, it constitutes an obstacle to navigation which is more serious than any other on the Nile north of Juba except possibly the Fourth Cataract. Like the latter the Second Cataract can be passed only on the crest of the flood and even then ordinary craft cannot ascend under their own power. Churchill gives a graphic description of a gunboat being hauled up in August 1896 with two thousand men on the tow ropes. This cataract differs from the others in that it consists of over 40 small islands divided from each other by a maze of rocky channels, as can be well seen from the air when approaching or leaving Wadi Halfa airport. The track from Wadi Halfa to Kerma follows at first the trace of the old railway which here hugs the river bank and affords some excellent views of the Second Cataract.

The last serious natural obstacle to navigating the Nile is the First Cataract, on which the Aswan Dam has been built 350 kilometres below Wadi Halfa and about 1,850 from Khartoum. The Wadi Halfa-Aswan reach is well known to many travellers because it forms part of the surface route from Khartoum to Cairo. The principal physical feature

is the narrow gorge at Kalabsha on the Tropic of Cancer about 50 kilometres south of Aswan which was at one time favoured as a dam site. Between Wadi Halfa and Aswan the Nile drops about 30 metres, which includes about 5 metres natural fall at the First Cataract. From here to the sea the drop varies from 85 to rather over 90 metres in 1,180 kilometres. With a full reservoir the Aswan Dam may be subjected to a head of about 35 metres, and the backwater effect may reach Wadi Halfa.

The foregoing description is believed to be substantially correct, but absolute accuracy of detail is not possible. The reason is that the points where cataracts begin and end are not sharply defined; hence their individual lengths and drops are liable to vary according to the observer, sometimes by quite considerable amounts. Overall changes of level and kilometrages can, however, be relied upon, for they have been taken from the latest official figures published by the Egyptian Government in Volumes III and VII of *The Nile Basin*. The main authority for the details of cataracts is an article in the Geographical Journal for July 1909 entitled "The Longitudinal Section of the Nile,"; it was written by Sir Henry Lyons, who was then in charge of the Egyptian Government Survey Department, and contains much valuable information. Additional details have been taken from *The River War* by Churchill and *Le Nil, Le Soudan, L'Egypte* by Chélu. The latter contains a complete set of plans in colour showing details of all the cataracts of any importance; it was published in Paris in 1891. The lack of more recent authorities is in itself an indication of the little interest taken in the subject during recent years.

3.—A Navigable Waterway from Khartoum to Dongola.

(See Maps 10, 11 & 12).

For practical purposes it can be said that the Sabaloka gorge is not safe for navigation unless the Khartoum gauge exceeds 12 metres. This it normally does from about the middle of July until near the end of November; on an average, therefore, Sabaloka can be passed safely during four months of the year at least. For reasons already explained, the longest period during which the Nile can be kept open for navigation between Khartoum and Wadi Halfa is about six months. There is therefore little to be gained by undertaking at Sabaloka works designed solely to extend the period of navigability. It might, however, be desirable to combine such works with a hydro-electric power scheme that would free Khartoum from dependence on imported fuel. Between

Khartoum and Shendi the Nile drops about 20 metres, and it seems probable that a dam built below the gorge could be designed to produce an effective head at low water of 10 metres. In the absence of an accurate survey such a figure must be somewhat conjectural, but it appears reasonable in the circumstances. The normal minimum flow is about 640 cubic metres per second, and the lowest ever recorded on the Tamaniat gauge was just over half this amount in 1922. If we allow an overall plant efficiency of 75% these flows would suffice to generate 64,000 and 32,000 HP respectively. Very low years like 1922 are most unusual, and will become even rarer when water can be stored in the great lakes of Uganda and Ethiopia ; we can therefore safely assume that 50,000 firm HP could be generated here.

Between Sabaloka and Abu Hamed there are, as already explained, two obstacles to navigation. In order to make the Nile passable these would have to be drowned out by means of weirs at Karaba and Shereik. Probably the former would have to be about 10 metres high and the latter rather less, but there can be no certainty in the absence of a careful survey. Being intended for navigation purposes only, each weir would be a solid overflow structure with crest designed to maintain at all stages of the river the minimum pool level required for navigation ; suitable locks would be provided at one end with walls rising above maximum flood level. Such structures, though massive, would be much simpler than the barrages of Egypt or pierced storage dams like those at Aswan, Sennar, and Jebel Aulia. Just below Abu Hamed it would be necessary to build a third weir, probably about 20 metres high but otherwise of the same type, in order to drown out the Mograt Island Cataract.

The series of rapids that stretches from Shirri Island to Karima constitutes by far the worst obstacle to navigation between Khartoum and Dongola. It is therefore natural to consider the possibility of drowning out the whole of this reach by means of a high dam near Karima. Fortunately the local topography lends itself to such a scheme, for the banks throughout are steep, rocky, and almost uninhabited. The Egyptian Irrigation Service is at present investigating such a dam ; it would have the double object of providing additional stored water to supplement that retained by the Aswan Dam and of protecting Egypt against very high floods. The upper part of the reservoir would have to be reserved for this latter purpose until all danger of a high flood had passed, though it could usually be filled up later in the season. From the point of view of navigation it would be desirable to fill the reservoir as soon as possible to a level which would drown out the

Shirri Island Cataract, leaving all storage capacity above this level as protection against a very high flood. The needs of irrigation and flood protection might conflict with these navigation requirements to a certain extent, and must, as already explained, have priority. Nevertheless, it should be possible to devise a scheme which would provide reasonable facilities for navigation without diminishing either the effective storage capacity of the reservoir or its value as a protection against high floods.

The possibility of generating electric power at the Fourth Cataract Dam is worth serious consideration. The maximum flow in a normal year is about 9,000 cubic metres per second, and the available head would be roughly 30 metres; hence the horse power would vary from over two and a half million when the reservoir was full to zero when it was empty. A certain amount of firm power could be developed by reserving for this purpose a depth of a few metres at the bottom of the reservoir. Egypt would, however, lose a small quantity of stored water, and it might for this reason be preferable to empty the reservoir and rely for two or three months on diesel or steam power units. But where, it will be asked, can any large amount of electric power be used? The answer, I suggest, lies in developing the lift irrigation of the Dongola district by means of large numbers of small electric pumps supplied from an electric grid system. The *sagia* (Persian water wheel) has the advantage that it is a simple device and is well understood by the local inhabitants, but it also has serious disadvantages. Of these the most obvious is that such a primitive and inefficient machine must be wasteful of both time and labour; but an equally serious drawback is that the draft animals which supply the motive power themselves consume a considerable part of the produce. The substitution of electric pumps for *sagias* would therefore increase the available food supplies even if no more land were brought under cultivation. In practice the flexibility of the grid system should allow considerable additional areas to be irrigated. Such land need not necessarily be in the immediate vicinity of the river, for electric pumps can work economically in wells provided there is an adequate supply of water at a reasonable depth. It may well be that the local depressions known as basins can best be developed for cultivation by pumping water electrically from wells scattered over the countryside. This method makes far more economical use of water than the present system of flooding and draining; moreover, if underground water supplies prove to be adequate, it would be far more reliable.

The records found in the Semna gorge make it practically certain

that in most parts of the northern Sudan the Nile has been subjected to a steady degradation of levels for many centuries past. It has thus become increasingly difficult for the inhabitants of the Dongola district to support themselves at home, because agricultural land that can be economically exploited has grown scarcer; for less has been flooded naturally, and the lift required to water a particular field has steadily increased. The result is that to-day the Dongola district is to a large extent denuded of its able-bodied men. This unhealthy situation will persist until we contrive to irrigate again those once productive areas which the lower floods of modern times no longer reach. To this persistent problem the technique of modern hydro-electric engineering offers for the first time a practical solution.

4.—A Navigable Waterway from Dongola to Wadi Halfa.

(See Maps 12 & 13).

The local topography of the Third Cataract is such that it might be cheaper to build a navigation canal round it on the right bank than to drown it out by means of a weir. This possibility arises because the right bank near Kerma is fairly flat and thus quite unlike the usual approach to a cataract. Continuing downstream, we reach the Kaibar Cataract, which is so short that here also a navigation canal round the obstruction might be the cheapest solution. The rapids at Amāra form such a slight obstruction that they will probably be passable during the period when the Nile as a whole is open to navigation; hence no work is likely to be needed here. From the head of the Dal Cataract to Wadi Halfa the Nile flows for nearly 100 miles through a rocky desert in a long series of rapids. Several control works will certainly be required to make this reach navigable and one of them must obviously take the form of a dam at the foot of the Second Cataract. If this were made about 30 metres high it would drown the rapids at Kajinjera and Semna, thus making the Nile navigable to the tail of the Ambigol Cataract. At this point a second dam some 25 metres high would drown out the Ambigol and Tanjur Cataracts, and extend navigability to the foot of the Dal Cataract. Here a third dam some 15 metres high would submerge the Dal Cataract and enable river craft to ply between Wadi Halfa and Kosha.

The foregoing series of dams has been suggested mainly with the object of indicating the lines on which the problem can be solved. Detailed investigation may, and probably will, show that it would be better to build some other number of dams differently sited. The

practical problem is to work out a scheme to serve the combined purposes of Irrigation, Navigation, and perhaps also Flood Protection. A thorough investigation will take time and will probably involve numerous trial designs of various dam combinations before a satisfactory arrangement is found. Considerable quantities of electric power could be generated, but it is not easy to see how they could be used. No doubt it would be technically possible to electrify the desert railway, but it is improbable that the high capital cost would be justified. In such a remote and inhospitable region industrial development seems unlikely, but perhaps advantage may one day be taken of the unusual combination of plentiful water power with a rainless climate which is found on this reach of the Nile.

In suggesting the construction of various dams and weirs we have tacitly assumed that it will be possible to find suitable foundations where they are needed. When the Aswan Dam was first built some fifty years ago, it was considered that there were no other suitable storage sites on the Nile. Since that time immense progress has been made in the art of erecting safe dams on inferior foundations, particularly in the U.S.A., and to-day it is true to say that we know how to deal effectively with almost any foundation material including sand. As long as the Aswan Dam could be heightened without undue difficulty there was little need to look for other sites ; but the time has now come when the irrigation engineers of Egypt have been forced to look further afield. The first result of their efforts has been a proposal for a dam near the tail of the Fourth Cataract, and there is talk of another in the region of the Dal Cataract. The fact of the matter is that foundation conditions between Khartoum and Wadi Halfa are in general by no means bad ; it is therefore most unlikely that modern methods would not enable engineers to build a weir or dam of ordinary height wherever it was required. In these circumstances the choice of a suitable site depends mainly on those local topographical features which determine navigability and reservoir contents for a dam of given height. Foundation conditions might well affect the choice between two or more possible sites, but it is improbable that they would ever render impossible a scheme that was otherwise desirable.

To develop the Nile on the lines suggested is a big undertaking. No doubt many will consider it altogether too ambitious for a country with the comparatively limited resources of the Sudan. This may be so, even though a large part of the cost will be a charge against irrigation and flood protection and hence fall on Egypt rather than on the Sudan. There are, on the other hand, good reasons for a moderate optimism ;

but it is obvious that no sound decision can be reached without a careful investigation on which to base a reliable scheme. The first stage of such a scheme would provide for dams at the Fourth and Second Cataracts; these would by themselves make it possible to navigate the Nile with reasonable safety for several weeks in a normal year. Subsequent stages would provide for the gradual completion of the full program, giving preference as far as possible to those works which would enable the period of safe navigation to be most rapidly extended. The development of the Tennessee river in the U.S.A. has shown what can be achieved by careful planning on a large scale; it has also demonstrated in a most spectacular manner what modern engineering can do. The appendix contains a brief description of these achievements and suggests that the technical problems to be faced by its Nile counterpart would be very roughly of the same order of magnitude. In these circumstances there can no longer be any good excuse for postponing a careful and thorough investigation into the possibilities of developing to their fullest extent the potentialities of that great river which already means so much to the Sudan and could mean so much more.

APPENDIX

THE TENNESSEE VALLEY AUTHORITY.

The Tennessee river joins the Ohio river at Paducah, Kentucky; a few miles lower down the Ohio itself joins the Mississippi at Cairo, Illinois. The primary object of the TVA was to provide a navigable channel at least nine feet deep at all times of the year from Paducah to Knoxville, Tennessee, a distance of 1,040 kilometres. The drop over this reach is about 155 metres; and the worst rapids are at Muscle Shoals some 400 kilometres above Paducah, where there is a difference of level at low water of about 40 metres in 40 kilometres. The Wilson Dam was built here and completed in 1925 after much delay and argument. No other dams were constructed until the TVA was formed in 1933. The Tennessee river is now navigable to Knoxville for craft which do not need a channel more than 9 feet deep, and the following is a complete list of the dams that have been built to achieve this purpose :—

	Kilometres above Mouth (Paducah)	*Lift in Metres*	*Cost in L.E. (millions)*
Kentucky	37	16	22
Pickwick	331	16	7
Wilson	414	30	8
Wheeler	440	15	8
Guntersville	558	13	7
Hales Bar	690	11	7
Chickamauga	754	14	8
Watts Bar	848	20	7
Fort Loudon	966	20	6
TOTALS		155	80

The figures in the last column are true completion costs, except that for Hales Bar which is an estimate. The lifts take no account of the river slope between dams, and are therefore on the high side.

On comparing the foregoing table with that for the Nile between Khartoum and Wadi Halfa, we find that both total length and total drops are roughly in the ratio of 2 to 3. The highest flood of the Tennessee ever recorded occurred in 1867 when the flow at Chattanooga (between Hales Bar and Chickamauga) reached 13,000 M^3/second. By

an odd coincidence the maximum mean natural flow ever recorded at Aswan for a ten-day period was almost exactly the same. This happened in 1878, and in 1946 the Main Nile discharge at Atbara reached the same figure. Had there been no spilling between Khartoum and Atbara, the discharge in the Main Nile below the Atbara confluence would have reached 14,750 M^3/second. The TVA have designed their dams to cope with a peak flood of rather over 20,000 M^3/second, which appears to allow a very generous margin of safety.

Despite certain rough analogies in the figures just quoted the Tennessee is, of course, a very different river from the Nile. The normal total annual discharge is 82 milliards at Aswan, but only 58 milliards at Paducah. The latter, however, is derived from a heavy rainfall averaging over 50" which falls on a catchment area of only about 40,000 square miles. The contrast with the Nile is very great. In such a wet climate there is naturally no need for irrigation, nor is any water required for that purpose in the lower Mississippi valley. After navigation, however, flood protection is most important, and over 12 milliards of reservoir capacity are reserved for this purpose. The third main purpose of the TVA is to generate electrical power in so far as that is possible without interfering with navigation or flood protection. Taking 1925 as a typical low year we find that natural river flow varied from about 130 M^3/second at Fort Loudon to about 520 at Paducah. The firm power which could have been generated during this period was estimated at approximately 600,000 HP ; the corresponding figure for the Nile, assuming a minimum flow of 400 M^3/second, would be about one million HP.

When deciding what storage volumes should be set aside for flood protection, it must be remembered that the Sudan is as much entitled as Egypt to adequate protection. During the great flood of 1946 nearly 3 milliards of water were spread over the countryside between Khartoum and Atbara, causing immense hardship and damage. Protection could be achieved, either by building flood protection reservoirs on the upper reaches of the Blue Nile in Ethiopian territory, or by erecting earth banks to prevent a high flood spreading. It seems probable that the second scheme will be found more economical, even though it will involve the provision of additional flood protection storage between Atbara and Wadi Halfa so that Egypt shall not suffer from the heightened flood peak. In general it is much more satisfactory to obtain flood protection by means of storage reservoirs than to rely on earth banks whose unreliability has been repeatedly demonstrated during recent years in the valley of the Mississippi. Conditions on the Nile are, however, unusual, and for this reason a careful study will be essential.

The commercial amenities that have arisen from the development of the Tennessee river have been found in practice to be of some importance, and the same thing might easily occur if the Nile were developed. An interesting possibility is that the "nimitti," which at present pester the inhabitants of the Dongola reach during the winter, might be eliminated or at least greatly reduced by suitable manipulation of water levels; for they are said to breed on rocks which have recently been exposed.[1] When the Nile has been developed it will offer over long reaches an almost unique combination of good communications, ample electric power, good water supplies, a practically rainless climate, and remoteness from unduly inquisitive outsiders. It is by no means impossible that a use may one day be found for these unusual amenities.

(*Concluded*)

[1] According to the latest information, they breed at the bottom of a fast-flowing stream; probably therefore damming of cataracts would eliminate them.—*Ed.*

THE TSETSE FLY PROBLEM IN THE ANGLO-EGYPTIAN SUDAN

By D. J. Lewis.

INTRODUCTION.

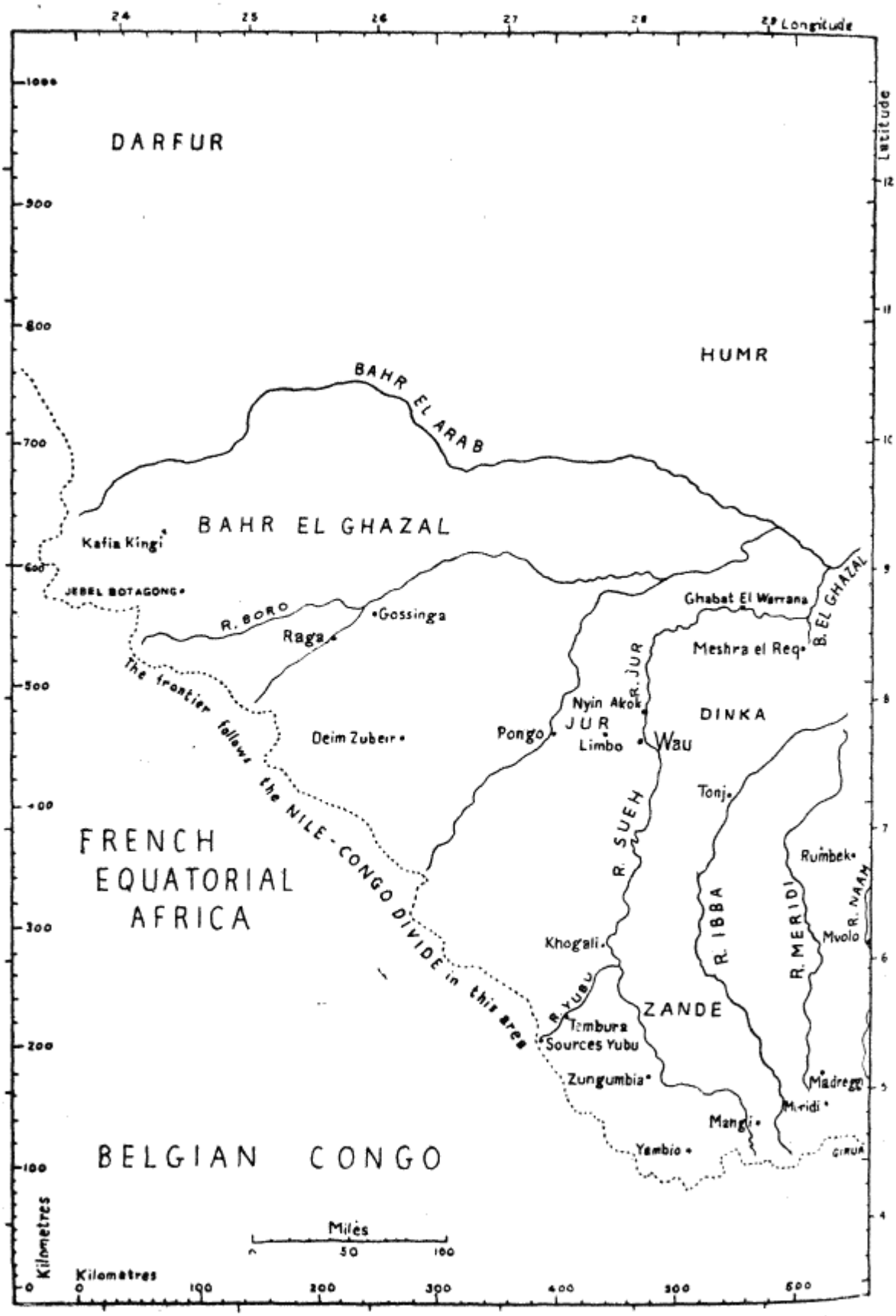
In the course of many years several methods of tsetse fly control have been developed in various parts of Africa and have proved highly effective in certain areas. At the present time it is appropriate to review the situation in the Sudan.

Sleeping sickness was brought under control many years ago in this country, but it is necessary to consider how the position can best be maintained and improved in the future, and what measures should be undertaken against *Glossina morsitans*, the vector of trypanosomiasis of cattle. The writer has not had occasion to study the problem in the field, apart from visiting the tsetse areas and making some collections. Much information on the distribution of tsetse flies and related subjects exists, however, and the purpose of this paper is to summarise it and provide a bibliography of the numerous publications which deal with or touch on the subject. Future control measures are a matter for discussion between several authorities and are only briefly referred to.

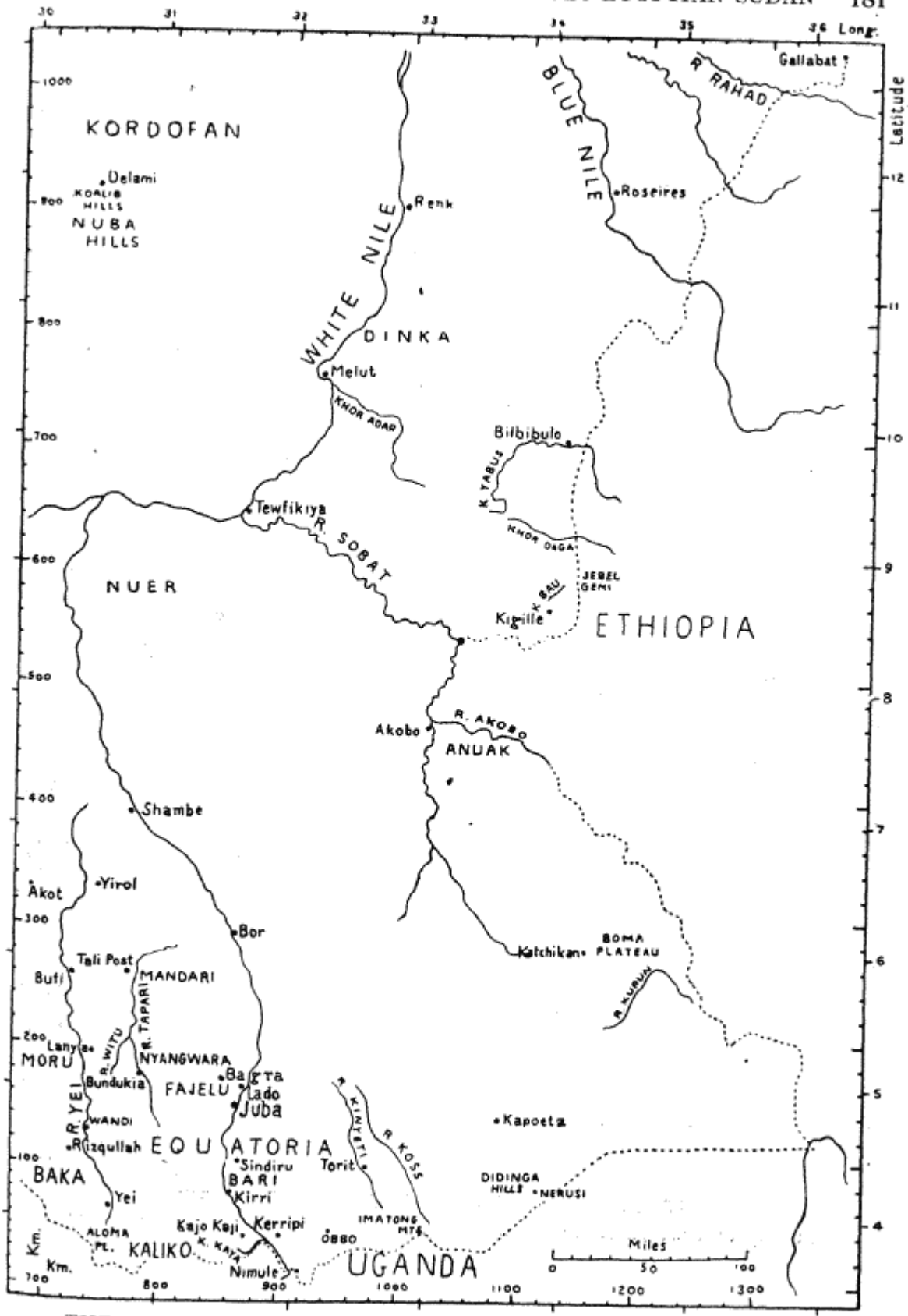
The Sudan and part of Ethiopia comprise most of the basin of the Nile. The tsetse country of the Sudan is that part which is far enough south to have sufficient rain and high enough to be above the grass swamp land near the river (Maps 3 and 4). West of the river the tsetse area slopes northward from the Nile-Congo Divide, with a small outlier in the Nuba Hills. In the east it comprises a few areas near the Imatong Mountains and a fringe of the Ethiopian tsetse area within the Sudan frontier.

The tsetse area is, so to speak, a horse-shoe round the Nile swamps, with three gaps, the valley of the Bahr el Ghazal with the southern Nuba Hills, the arid country east of Kapoeta, and the Sobat area where the tsetse fringe passes through Ethiopian territory.

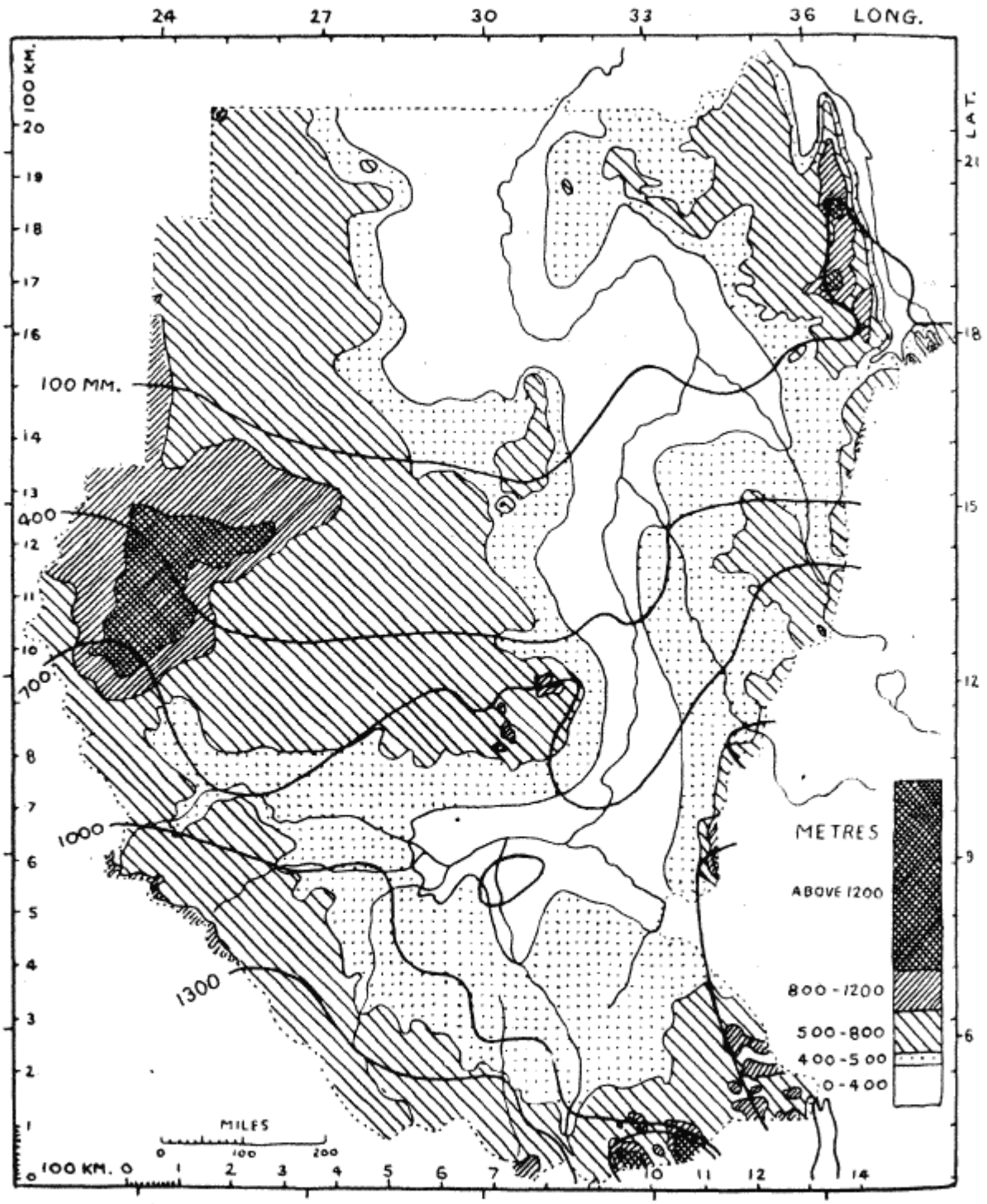
The main, south-western, tsetse area has a moderate seasonal rainfall and consists mainly of lightly wooded country traversed by



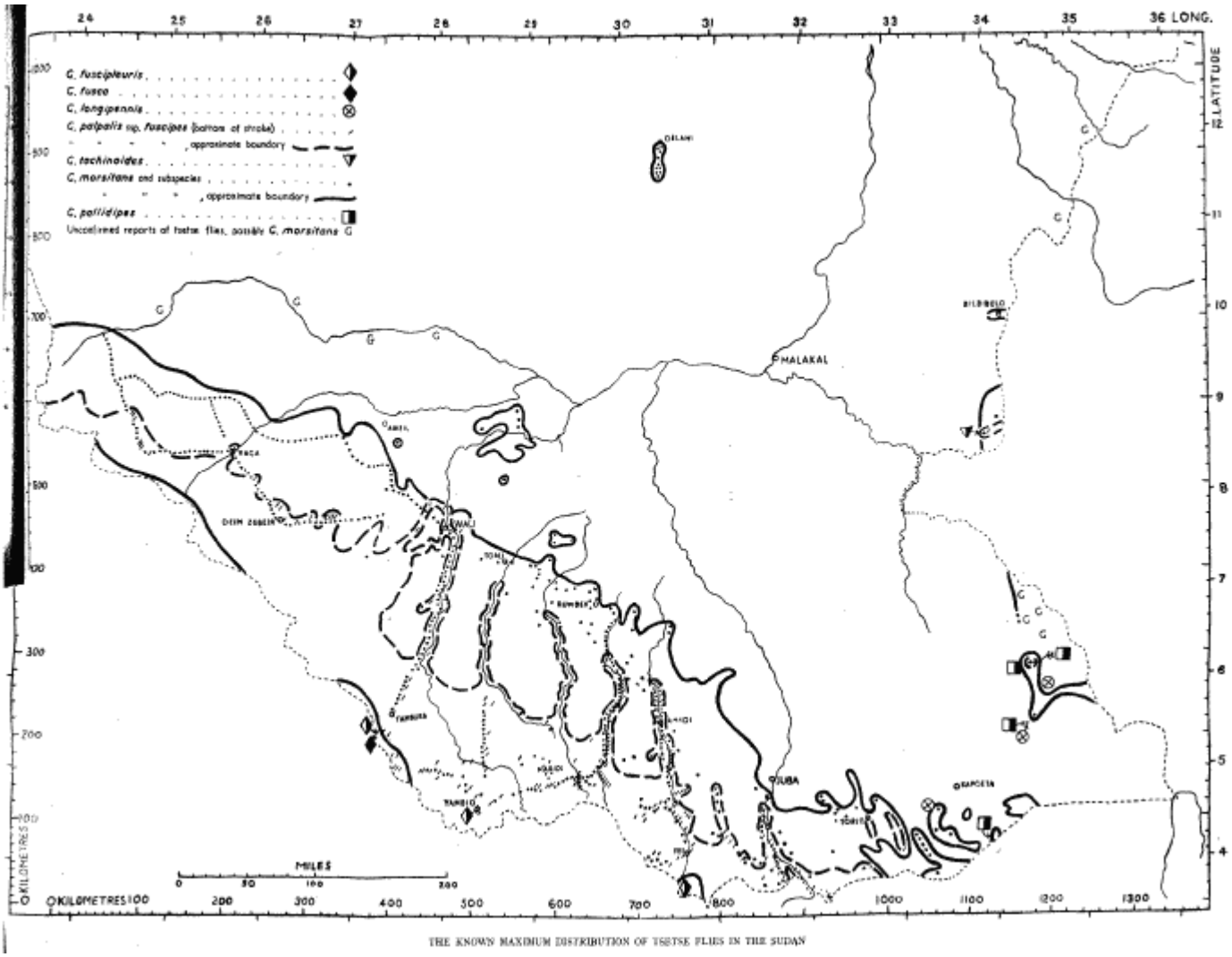
THE SOUTH WESTERN SUDAN (showing places mentioned in the text)



THE SOUTH EASTERN SUDAN (showing places mentioned in the text)



TOPOGRAPHY AND RAINFALL OF THE SUDAN
(showing by selected contours and isohyets). Partly after Tothill *et al.* 1948



THE KNOWN MAXIMUM DISTRIBUTION OF TSETSE FLIES IN THE SUDAN

narrow fringes of dense bush along rivers which flow north towards the great swamps. Most of the swamp land is subject to seasonal flooding and is composed of grassland with scattered patches of light bush. In places it forms a topographical, instead of climatic, northern limit of tsetse flies. The main tsetse area is occupied by *Glossina morsitans* and its sub-species, with *G. palpalis* ssp. *fuscipes* (referred to below as *G. palpalis*) following the streams and rivers. *G. fuscipleuris* and *G. fusca* occur near the Nile-Congo Divide, and *G. longipennis* was recorded many years ago in arid country east of the Nile. *G. tachinoides* has been found in one place in the east, and *G. pallidipes* has so far only been found four times, in the south-east.

The known distribution of these seven species in the Sudan will be shown in colour on maps of Africa and of eastern Africa which are being prepared by Mr. W. H. Potts, Director of the East African Tsetse Research Organization at Shinyanga, Tanganyika. Map 4 in the present paper shows the general limits of distribution together with marks indicating individual records. Anyone who is willing to contribute to our knowledge of distribution can render valuable help by collecting specimens at points not marked on the map and forwarding them for identification, as explained below.

Sleeping sickness is no longer a serious question but it is desirable to find less expensive and time-consuming methods of keeping it down to the present very low incidence in existing villages and towns and in new settlements.

The control of bovine trypanosomiasis is an important problem and it remains to be seen what methods will be feasible against *G. morsitans*. An area of possibly 230,000 square kilometres (nearly 90,000 square miles) is almost devoid of cattle and is believed to be mainly occupied by tsetse. A large area, mainly of grass land, to the north is subject to sporadic outbreaks of cattle trypanosomiasis up to a distance of some 300 kms. (about 180 miles) from the main tsetse areas. The disease, which can kill tens of thousands of cattle in a bad year, is thought to spread from reservoirs of trypanosomiasis in tsetse country and to be transmitted by other biting flies.

EARLY REPORTS OF TSETSE FLIES.

When Westwood (1850) described *G. morsitans* from South African specimens he referred to the fly found in the Sudan in 1772 by Bruce, the explorer, and regarded it as the same species. This fly can now be easily recognised as *Pangonia ruppellii* Jaennicke, a Tabanid, but for

many years later writers, some of whom are mentioned by Austen (1911), confused the two species of "fly."

Petherick (1861), who travelled near El Obeid in 1948, wrote (p. 282) of refugees from Kordofan who had fled to the negro country in the south but had been driven back "by the ravages committed on their cattle by the tsetse fly during the rainy season." Having ascended the Bahr el Ghazal in 1855, he (pp. 393, 394) contrasted the Jur tribe with some of the cattle-owning peoples of the swamps. He wrote of the Jur: "different habits prevail, which are solely attributable to an insect—viz. the tsetse fly. So deadly to animal life is the effect of the sting....that goats are the only domestic animals which escape the consequences; therefore the Djour are strictly agricultural, they cultivate more ground than is absolutely required for the sustenance of their families." The excess was partly to exchange with the Dinka for cattle.

Baker (1866), who visited the Obbo area in July 1863, encountered numerous biting flies, some of which he considered to be tsetse, and asserted that most cattle in the neighbourhood were killed by the flies.

The Pethericks (1869), when travelling near the present Akot in September 1869, were informed that a certain village was untenanted at that season owing to the presence of tsetse or *mau*, and that the fly occurred in the bush a little further south. They stated that the natives knew the type of bush occupied by the fly and were aware that cattle could graze with impunity not very far from it. On halting in thick bush they netted some flies which resembled the tsetse flies mentioned by Livingstone, although they were possibly smaller. After passing Mvolo the Pethericks again recorded tsetse flies which were there called *merchae*.

Gessi (1892), who visited Rumbek in 1878, referred to the destruction of oxen by the tsetse fly.

The century ended without any confirmed specific records from the Sudan, and Austen's (1903) map shows but two non-specific records based on Baker's and Petherick's reports.

TSETSE SURVEYS.

According to Balfour (1904*a*) neither trypanosomiasis nor *G. palpalis* had been found in the Sudan. The very severe outbreak of sleeping sickness in Uganda at the beginning of the century created considerable apprehension in the Sudan and soon extensive searches were made for *G. palpalis*. In due course much was discovered about its distribution

and also that of *G. morsitans* which, however, was not considered to be of primary interest.

Greig (1905 *a*, *b*, *c*), of the Royal Society's Sleeping Sickness Commission in Uganda, descended the Nile Valley from Nimule to Khartoum, and Neave (1906) continued the search inland.

Balfour (1906) wrote of the danger of sleeping sickness spreading from Uganda or the Congo and announced the appointment of the Sudan Sleeping Sickness Commission whose work was taken over by the permanent authorities in 1918. Dansey-Browning (1906) was a member and was succeeded by Ensor (1908, 1909, 1914) who made many observations on the distribution and habits of *G. palpalis* and *G. morsitans* and advocated the appointment of a medical officer for sleeping sickness work. R. G. Anderson (1911 *a*) was appointed and published his observations with maps compiled from various reports and specimens. Mathias (1911), president of the Commission, published maps of distribution, including the newly incorporated Lado Enclave, and Drew (1911 *a b*), a member of the Commission, contributed observations on the habits of *G. palpalis*. He found this species, in the dry season, on every water-course examined along the road between Limbo, Raga and Jebel Botagong but not further north.

King (1912) made a tsetse survey west of the Nimule-Shambe reach of the Nile and published a map and notes on the two species, and Chalmers and O'Farrel (1914) published a map of the Nimule-Yei area.

Stigand (1923), who knew the area from 1908 to 1919, wrote of the wide distribution of *G. palpalis* and *G. morsitans* and suggested, without giving a reason, that they were atypical.

Some of the information gained in early surveys was incorporated in the well known work of Newstead, Evans and Potts (1924).

Ruttledge (1928) studied *G. morsitans* in the Koalib Hills, the only part of the Nuba Hills in which it occurs, and Bedford (1930) published small-scale maps of the distribution of the species then known in the Sudan. Nalder's (1936) map showed the "tsetse-fly" area of Equatoria Province on a larger scale.

The late Dr. J. G. Myers, while carrying out plant ecological surveys from 1940 to 1942, made many notes on tsetse distribution in his (unpublished) records. In the north he found *G. morsitans* in many places where it had been reported some 30 years before. He established additional records of tsetse in the Boma, R. Jur and Torit areas and found that *G. morsitans* was very scarce in the Yei area.

Mr. H. B. Luxmoore and Mr. P. Z. MacKenzie, M.B.E., veterinary

inspectors of Equatoria and Bahr el Ghazal Provinces respectively, have provided the writer with much information on distribution in 1949.

NOTES ON THE SPECIES.

The known maximum distribution of the species is shown in Map 4 which is compiled from the various sources mentioned in this paper. Certain records have been discarded owing to the uncertainty of tracing old place names. Some of the unconfirmed records, indicated by " G " on the map, should be accepted with caution because some non-technical writers have confused tsetse flies and Tabanidae under the term " fly."

Glossina fuscipleuris Newstead

Newstead, Evans and Potts (1924) recorded this species from the R. Yubu and Yambio. It and *G. fusca* probably occur in many localities along the Nile-Congo Divide.

G. fusca Walker.

The structure of the male terminalia is variable and usually intermediate between the type form and ssp. *congolensis* Newstead and Evans.

Newstead, Evans and Potts (1924, p. 244) first recorded the species from the Sudan, and Zumpt (1936) recorded it from the Tambura area.

G. longipennis Corti.

Chalmers and King (1913) recorded this species from two localities, and Mr. H. B. Luxmoore found it on the R. Kurun at 34° 25′ E. in 1949.

G. palpalis ssp. fuscipes Newstead.

Newstead (1910) described this subspecies from a Nimule specimen. Austen and Hegh (1922) recorded it from the Sudan, and Bedford (1930) examined many males and found that *fuscipes* was the only form in this country. Vanderplank (1949 *b*) showed *fuscipes* as the Sudan form but did not map its Sudan distribution correctly. Although he considered that *fuscipes* was most probably completely isolated from the rest of *G. palpalis* and mapped it considerably north of the Belgian Congo, the variety does occur on the frontier of that country.

In West Africa *G. palpalis* varies in size and colour (Nash, 1937 ; Newstead et al., 1924 ; Vanderplank, 1949 *c*) ; in the north rather pale specimens are common and small forms occur in some areas. In the Sudan comparable variation is found. Along the northern limits of the

species the flies tend to be smaller and some show slightly yellow pale abdominal bands. Myers wrote in his field notes of a " small *morsitans* — like *palpalis* " biting in the rest house and near the river at Nyin Akok. The small pale specimens can easily be distinguished from *G. tachinoides*. Another instance of pallor near the northern limit of a specimen is seen in *G. pallidipes*.

Distribution.

The following are some detailed records, and many others are to be found in the above-mentioned reports. According to Greig (1905 *a*, *b*, *c*) and Greig and Gray (1905) *G. palpalis* occurred near Kiri and extended northward along the Nile until undergrowth and close woodland ceased not far from Juba.

Balfour (1905, 1906 *c*) recorded *G. palpalis* from near Madreggi and had received reports that it occurred at Mvolo and Wandi and was abundant south-east of Mvolo. Hodges (1907) found it on most small streams between Nimule and a point in the Sindiru area. Wenyon (1908) ascended the R. Sue for ten miles above Wau and found several *G. palpalis* in September 1907. Ensor referred to the prevalence of this species on the R. Naam south of Mvolo and on the R. Maridi. He found that the rivers Sue, Ibba, Maridi and Naam formed important linear northward extensions of this species, probably as far as the great swamps. He seldom found *G. palpalis* and *G. morsitans* together, and noted that both species increased during the rains. The former was often seen resting on the ground beneath fallen leaves or vegetation.

King (1912) found *G. palpalis* on many streams of the Nimule-Juba part of the Nile Valley and was sometimes pestered by as many as 20 flies at once. The species was plentiful near Rizqullah and on several parts of the R. Yei between Yei and Bufi, and was apparently absent from the Girua area. King stressed the difficulty of finding *G. palpalis* where it was scarce. Christy (1917) thought that *G. palpalis* was unlikely to cross the frontier near Tambura.

Stigand (1923) found the Tapari and Witu rivers infested with this species and considered that the Tapari near Bundukki was probably its local eastern limit and that it did not occur on the Nile north of the R. Kaia. Bedford (1930) recorded *G. palpalis* from near Bilbibulo and thought that it extended down the Khor Yabus to the swamps. Nalder (1936) reported that this species had been found to infest the Kinyeti and Koss Valleys.

G. tachinoides Westwood.

This species, an important vector of trypanosomiasis in West Africa,

was discovered at Kigille in 1948 by Dr. J. F. E. Bloss, but it is thought to be absent from the main tsetse area of the Sudan (Lewis, 1949). A collection sent from Kigille in 1949 by Captain G. S. Renny comprised two female *G. palpalis*, 12 male and 14 female *G. tachinoides*, and one male *G. morsitans*.

G. morsitans Westwood.

In addition to the type form, the West African form *submorsitans* Newstead, 1910, has been recorded in the Sudan by Austen (1911), Symes (Hunt and Bloss, 1945) and Newstead (1910, 1924), although Bedford (1930) considered that only the eastern, type, form existed.

Although *submorsitans* was originally described as a species, Austen (1911) regarded it as merely a form or race of *morsitans*, and Patton (1936) considered it to be only a variety without constant distinguishing characters. It is not unlikely that most of the *G. morsitans* in the Sudan are ssp. *submorsitans* race *ugandensis* Vanderplank (1949 *a*). For the present all specimens are recorded as *G. morsitans*.

Dansey-Browning (1908) described some dark tsetse flies from uninhabited forest in the western Sudan and regarded them as a dark variety of *morsitans*. This finding led Newstead (1910) to examine the male terminalia of these and other specimens. He then described *submorsitans* and regarded these Sudan specimens as a dark variety of it. The present writer has examined many preserved and some fresh specimens of *G. morsitans* without finding any marked colour variation.

Distribution.

Balfour (1904 *a b*) reported that *G. morsitans* was abundant near Pongo, where it had been found in 1903 (Greig, 1905 *a*; Christopherson, 1905), and a tsetse fly belt was said to exist about ten miles west of Shambe. According to Greig this species was reported to occur six miles west of Shambe, on the R. Jur near Wau, and on the Bahr el Ghazal (R. Jur ?) where it was said to be more numerous on the more thickly wooded west side.

Neave (1906) found no tsetse flies in the grass country north of Juba and then walked from Shambe to Wau and Meshra el Req in April. He found *G. morsitans* once before reaching Rumbek and about five miles east and west of Tonj. He was told of a large fly harmful to cattle between Rumbek and Tonj, and of "fly" areas along most of the Tonj-Wau road, 15 miles north of Wau, and elsewhere. He noted that the fly followed him into Tonj, and commented on its patchy distribution and habit of following. He and King (1912), stressed the difficulty of finding the species where it was scarce.

Balfour's (1906) map showed 12 localities of *G. morsitans*, including the Koalib Hills. The fly was said to cause great loss among mules and donkeys, the insects attacking the leading mules in a caravan. As early as 1907 experiments with motor lorries were carried out, between Wau and Rumbek, owing to the deaths of transport animals.

Dansey-Browning (1908) reported *G. morsitans* and animal trypanosomiasis near Gossinga.

According to Ensor (1908) this tsetse was extremely common and very annoying in most parts of the Bahr el Ghazal Province, causing heavy mortality in transport animals on the Maridi-Mvolo and Khogali-Wau roads where its abundance was attributed to the presence of game. Ensor (1909) found that *G. morsitans* was rare in the forest near Tambura, Yambio and Zungumbia. Kumm (1910) reported that tsetse were abundant near the R. Boro and, in 1909, between Deim Zubeir and Wau.

R. G. Anderson (1911 *a*) emphasized the importance of caravans and herds of game in spreading *G. morsitans* which, in the traffic season, was seen almost everywhere along well used roads but was otherwise localized.

King (1912) did not encounter large numbers of *G. morsitans* in the country west of the Nimule-Juba part of the Nile, and found very few in the latitude of Yei and further south. Christy (1917) referred to *G. morsitans* as an intolerable pest between Yambio and Tonj and between Tonj and Wau. Christy (1918) observed great numbers of this species in the Bahr el Ghazal Province and discussed the relation of the fly to game, grazing facilities and trees. According to Stigand (1923) *G. morsitans* was common on the Lado-Bundukia road and " fly " was common on the upper R. Tapari where cattle could not live. Tsetse were scarce or absent near Lanya where cattle had apparently been kept in former days.

In the annual reports of the Sudan Veterinary Service are mentioned a supposed mile-wide tsetse area on the Bahr el Arab in Darfur and Kordofan, tsetse areas south of Wau and near the Khor Bau, a report of tsetse on the upper R. Rahad, and *G. morsitans* in the Roseires district.

Titherington (1927) referred to *G. morsitans* north of the ironstone country in the Ghabat El Warrana area, the absence of cattle there, and the danger that any extension of the fly would lead to over-grazing and tribal disputes Mr. P. Z. MacKenzie, in correspondence, has suggested that the area should be known as the " Jur Narrows tsetse fly island," and has informed me that between January and May cattle approach it in large numbers from all directions except the north.

Mellor (1928) observed the biting habits of *G. morsitans* near Kerripi in November but saw none further north.

The Koalib Hills are remarkable because *G. morsitans* has survived in spite of the disappearance of big game (Archibald, 1927 ; Ruttledge, 1928 ; and Nadel, 1947) and feeds largely on domestic animals. The inhabitants used to regard the tsetse fly as an asset because it deterred the Arabs from grazing their cattle near the hills (Government Entomologist, 1928). According to Sagar (1922) the Nubas were said to have introduced tsetse flies among the cattle of their enemies by trapping the insects in a gourd of blood and releasing them at night where they wished. *G. morsitans* was found at Delami, north of the hills, in 1936 (Sudan Medical Service Report for 1936).

Bedford (1936) believed that *G. morsitans* might occur during the rains along the Ethiopian frontier between the Khor Yabus and Gallabat and perhaps still further north.

Nalder (1936) described the tsetse-fly area of Equatoria as "a continuous fly-belt with small fly-free enclaves on the Kajo Kaji and Alluma plateaux," and indicated a 10 to 20 km. rainy season extension of the tsetse area between Mvolo, Tali Post and Bagra. Driberg (1930) mentioned the dry season retreat of the fly in the Didinga area.

According to Corfield (1938) *G. morsitans* occurred and prevented the keeping of cattle in many of the small villages of the Gemi area. Goats could live there for a time and some cattle could be kept in the Daga valley.

Hoare (1940) discussed areas in which camels might have come in contact with tsetse flies and acquired trypanosomes which could have developed into *Trypanosoma evansi*, the camel trypanosome. He showed the distribution of *G. morsitans* extending further north than Gallabat but in his map distribution is partly inferred from the distribution of bovine trypanosomiasis. Even if *G. morsitans* is eventually found to be less widely distributed than Hoare believed, this finding would not necessarily affect his argument because it may be supposed that before *T. evansi* developed, the camel came somewhat further south.

Morrice and Winder (1946) suspected that tsetse flies occurred on the upper Khor Adar as well as the Khor Yabus, and also referred to cattle of the Bari tribe which graze along the Nile away from *G. morsitans*.

Symes (Hunt and Bloss, 1945) recorded *G. morsitans* near Li Yubu but it appeared to be absent in many places in the vicinity and probably overlapped the area of *G. palpalis* further north on the Yubu, Sue and other rivers. A. B. Anderson (1947), Evans-Pritchard (1940, 1947) and Lyth (1947) referred to the distribution of *G. morsitans* east of the Nile.

Apart from one doubtful record, this species is unknown on the wooded banks of the Blue Nile, possibly owing to the density of population and scarcity of game.

It is well known that *G. morsitans* is usually associated with big game. Among the publications which refer to the distribution of game are official reports (Sudan Government, 1947, 1948; Sudan No. 1, 1923-1939).

Glossina pallidipes Austen.

In specimens from the Boma Plateau the abdomen is rather pale. According to Vanderplank (1948 *b*) the markings of *G. pallidipes* vary with season and locality.

Balfour referred to an unconfirmed report of this species from Mangi; Swynnerton (1936) recorded it from Nerusi; Myers found it on the Boma Plateau in February, 1939; and Luxmoore took it on the R. Kurun and at Katchikan in 1949. Since this species is sometimes difficult to detect and is known south of Nimule (Austen and Hegh, 1911) it may exist undetected at several places near the border.

GENERAL NOTES ON DISTRIBUTION

Discontinuous distribution

Discontinuity is a feature of the distribution of many insects in the Sudan, and two striking examples are seen in the tsetse flies, *G. tachinoides* and *G. morsitans*. It is not unlikely that past changes in climate may be responsible. Some thousands of years ago the Sudan passed through periods wetter and drier than the present day (Tothill *et al.*, 1948, p. 4) and both species may have lived in the intervening areas under different climatic conditions.

The case of *G. tachinoides* is so interesting that one may perhaps speculate as to its past history. As far as we know there is a wide gap of some 1,700 kms. (over 1000 miles) in its distribution, from the interior of French Equatorial Africa to the border of Ethiopia. Yet in the south-western Sudan conditions of climate and vegetation appear to meet its requirements as described by Nash (1948), and one might have expected to find it along the northern limit of *G. palpalis*. It seems possible that during a drier period *G. tachinoides* may have occurred near the Nile-Congo Divide and eastward into Ethiopia. During a wetter period the rivers which flow north from the Divide were probably fringed with dense forest and *G. tachinoides* may have spread northward until it became sandwiched between forest and swamp and died out.

When the present day climate developed re-colonization from the west was probably prevented by belts of relatively dry country running mainly north and south. Re-entry from the east is prevented by large areas of swamp and of higher ground with a low rainfall. There is no important road along which *G. tachinoides* is likely to be introduced by motor traffic.

G. morsitans may have covered a wider area during a wetter period and become isolated in the Koalib Hills as a result of arid conditions.

Vanderplank (1949 *b*), has suggested that at one time the distribution of *G. pallidipes* might have been continuous with that of the closely allied *G. longipalpis*, during the last pluvial period, across or near the region which is now the southern Sudan.

Reports of changes in distribution.

Tsetse and the slave trade.

During the nineteenth century the southern Sudan was subjected to extensive slave raiding. Many thousands of cattle were removed and much of the country became depopulated. Some of the raids were described by Junker (1890) who travelled between Wau and the present Juba and south-west of Juba in 1877 and 1878. Hill (1939) has listed the works of Schweinfurth (1890) and other travellers who described the results of the slave trade. The absence of transport animals for carrying ivory apparently contributed to the demand for slaves. According to Felkin (1883) cattle were the chief wealth of the Moru tribe. Stigand (1923) described the Bari of Equatoria as a pastoral tribe who had lost their cattle in raids. According to Nalder (1936, 1937) the Baka and Moru had probably had large herds a century before and some of the institutions of the latter exhibited a cattle-owning basis. The Fajulu, Kaliko and Nyangwara tribes and possibly the southern Bari had formerly had many cattle.

Referring to the slave trade, Nalder wrote : " With the disappearance of the cattle and a very great reduction in population the forest encroached on the cleared areas and with the forest the fly, which makes the restocking of the country a matter of great difficulty.

A comparable change has possibly taken place in more recent times in the Yei and Moru Districts where, according to Tothill *et al.* (1948, p. 889), the destruction of cattle by rinderpest and bovine pleuro-pneumonia may have allowed bush to revert to a type thick enough for *G. morsitans*.

The position in part of the Sudan may be comparable to the

Nubarara area of Uganda ; Buxton (1948, p. 29) discussed an advance of fly there and pointed out that the same natural events can occur in widely separated areas in the uniform conditions of Africa.

Effects of human settlement.

Maurice (1930 *a*) wrote of the southern Bahr el Ghazal : " Some of the roads, before the people settled on them, swarmed with *Glossina morsitans* and made travel a misery, but once they became populated, *Glossina morsitans* completely disappeared. I have travelled the length of Tambura sub-district and not seen a " fly " ; entered the uninhabited seven-mile belt between Yambio and Tambura sub-districts and found tsetse swarming ; similarly, travelling north to Wau, I have met no fly on the inhabited roads, but as the population petered out and the road became uninhabited so the " fly " increased proportionately..... its withdrawal before a concentrated population is of interest, when the introduction of cattle is contemplated...."

Hunt and Bloss (1945) noted that the game, and apparently *G. morsitans*, left country which had been occupied by members of the Azande, a tribe of persistent hunters.

***G. morsitans* and roads.**

Although great numbers of tsetse flies were mentioned by early workers one can now travel hundreds of miles across the southern Sudan in the dry season without seeing more than a few individuals. In the rains of course more are seen. The apparent discrepancy between old reports and present experience may be due to the effects of motor transport. Since cars were introduced many roads have been re-sited along watersheds instead of rivers ; tsetse flies are no longer spread along the roads by transport animals ; cars usually travel too fast to attract the flies and they tend to drive game animals from the vicinity of roads.

According to Nalder (1936) it was generally believed that *G. morsitans* had diminished during the previous two years ; he attributed this either to a rinderpest outbreak and reduction of game or to a retreat from the roads. Bloss (1945) pointed out that the roads had become less attractive to tsetse when motors replaced ponies and mules, and I am informed by Mr. J. Winder that tsetse were far more numerous on the Juba-Nimule road in 1931 than they are now after years of motor traffic.

***G. morsitans* and rivers.**

There is a tendency for *G. morsitans* east of the Nile to extend north-

ward along rivers, like *G. palpalis*. To the west on the other hand, in less arid country, *G. morsitans* occupies the surrounding country in which it sometimes extends further north than the rivers after they have reached their swampy sections.

Occasional fluctuations.

Apart from the well known seasonal spread and recession of *G. morsitans* both advances and retreats have been reported from time to time. It is probable that the range of this species fluctuates, but it seems unlikely that any permanent large-scale advance will take place. Regarding the northern limit of *G. morsitans*, however, it is interesting to note that not far away in Uganda it can live in comparatively open country (Buxton, 1948 ; Uganda, 1948).

In certain areas local advances are quickly noticed because they arouse apprehension that cattle owners will be driven to use their neighbours' grazing grounds with consequent disputes and possibly bloodshed.

R. G. Anderson (1911 *a*) reported an advance of some 40 miles towards Rumbek in 1906 and the steady retreat of cattle-owning Dinka before it. An advance towards Rumbek was also reported in 1937. Ruttledge (1928) has discussed fluctuations in the distribution of *G. morsitans* in the Koalib area, and Bloss (1945 *b*) referred to a possible advance north of the Juba-Torit road and along the R. Kinyeti near Torit. Lyth (1947) wrote of a report that tsetse had advanced southward from the R. Akobo some 50 years before. *G. morsitans* is said to have left the Shambe-Yirol area a few years ago.

Spread of tsetse flies has been reported from the region of the southern borders of Darfur. Dr. C. B. Drew informs me that when he visited the Kafia Kingi area in 1935 the inhabitants reported an increase in tsetse which they attributed to a reduction in the human population. More recently encroachment of tsetse has been reported to cause avoidance of extensive grazing areas not far from that region (*Sudan Veterinary Service Report for* 1945 : Sudan Gov., 1948, p. 186).

TRYPANOSOMIASIS IN DOMESTIC ANIMALS.

The tsetse fly areas.

Equatoria and Bahr el Ghazal Provinces.

Balfour (1906 *c*) reported the finding of trypanosomiasis in domestic animals in the Bahr el Ghazal in 1904. In the days when trypanosomiasis

in transport animals gave much trouble Wenyon (1908) studied equine trypanosomiasis in relation to *G. palpalis* and *G. morsitans* at Wau and discussed the possible transmission of *Trypanosoma congolense* by *G. palpalis*. Trypanosomiasis was soon found to be common in the two provinces and cattle to be non-existent in most of the tsetse area. The position has been discussed by Fry (1911), R. G. Anderson (1909 *b*), Webb (1915) and Nalder (1936) and in the annual reports of the Sudan Veterinary Service. According to Manning (1947), Emin who lived in Equatoria from 1876 to 1885, attempted to breed cattle immune to the prevalent disease. Staniforth (1948) kept a herd of cattle from contact with fly bush by fencing.

R. G. Anderson (1911 *b*) wrote of the effect of meat shortage on the diet of the southern tribes. Tothill *et al.* (1948, pp. 269, 586, 589, 590, 594) have discussed the question of diet ; it has been said that the cultivators lack vigour and that there is an " all-prevailing and ever-persistent longing for meat," but it appears that meat may perhaps be regarded as a luxury for them rather than a necessity[1]. The deficiency of animal protein in the diet and the production of pulses in tsetse areas are mentioned. Woodman (1947) discussed the present diet of the people of south-western Equatoria and concluded that further study was required before the necessity for a supply of meat was established.

Tothill *et al.* (p. 915) pointed out that the lack of animal transport is at present an obstacle to agricultural development.

There is some evidence that diet deficiency in the tsetse areas plays a part in determining the incidence of leprosy (Atkey, 1934, 1935 ; Bloss, 1946 ; Nalder, 1936 ; Tothill, *et al.* 1948, pp. 272, 589 ; Woodman, 1947).

The Koalib Hills.

A breed of dwarf cattle, believed to be immune to trypanosomiasis, exists in this tsetse area (Archibald, 1927 ; Balfour, 1913 ; Ruttledge, 1928 ; Tothill *et al.*, 1948, p. 838) and probably once occurred among all the Nuba tribes (Nadel, 1947).

Camel trypanosomiasis prevails far beyond the tsetse areas but an exceptional infection with *T. congolense* near the Koalib Hills is mentioned by Bennet, (1933) and in Sudan Veterinary Service reports.

Khor Bau.

An outbreak of trypanosomiasis in a caravan passing through this area is described in the veterinary reports.

[1] The Moru tribe have a special word for " meat hunger " different from the ordinary word for " hunger."—*Ed.*

The effect of tsetse flies on the distribution of people.

During the thirteenth, fourteenth and fifteenth centuries the Arabs occupied the north and centre of the Sudan (MacMichael, 1934), and so determined the present main ethnic division of the country. It may be assumed that trypanosomiasis in parts of the tsetse area and in the tsetse-free country further north played some part in determining the limits of the cattle-owning Arab tribes, as we have noted in the case of the Koalib Hills. Trypanosomiasis in transport animals must have contributed to this effect.

The camel was introduced into Africa in historical times (Tothill *et al.*, 1948) and may have reached the vicinity of the tsetse areas with the Arab invasion. If, as Hoare, (1940) suggests, *T. evansi* may have developed from *T. brucei* in the Sudan or West Africa, the camel-owning tribes might have occupied country as far south as the tsetse areas until *T. evansi* became prevalent in the Tabanid areas and helped to determine the present limit of the camel.

Stubbs and Morison, (1938) pointed out that the Dinka were confined to their alluvial plains by the presence of the Arabs to the north and the tsetse to the south and west.

Evans-Pritchard (1938, 1940) discussed the effect of *G. morsitans* on the distribution of the pastoral and semi-nomadic, Nilotic, Nuer Tribe. A tsetse area is an impassable barrier to them and they occupy country which is devoid of shady bush, partly, perhaps, because it is regularly flooded and burnt. The prevalence of tsetse flies in the forest along the foothills of Ethiopia evidently limited Nuer expansion eastward, and tsetse, by killing their stock, probably helped to drive them rapidly from Anuakland which they had overrun about 50 years before. The Anuak themselves have changed their mode of life as a result of living in tsetse country.

Areas believed to be free of tsetse.

Reports of the disease.

Trypanosomiasis in these areas is briefly discussed below, chiefly in so far as it is concerned with the tsetse areas.

Trypanosomiasis was reported in domestic animals at Melut and Tewfikiya and near Kodok by Balfour, (1906 *c*). He considered however that the country was not sufficiently developed for this trypanosomiasis to be an important problem and that game was then probably more valuable than the domestic animals. Little prophylaxis was considered possible but steps were taken to limit the northward movement of

southern cattle. According to one opinion, however, (Egypt. No. 1, 1906) trypanosomiasis was unlikely to spread beyond the tsetse area. Balfour (1908) recorded trypanosomiasis in the absence of *Glossina* in Kassala Province (not shown in Map 2) and alluded to the existence of other biting flies. Wenyon, (1908) referred to trypanosomiasis on the upper Sobat, and Fry (1911) discussed the subject in general, and Archibald (1912) referred to the situation in Bor district.

Evans (1936) wrote of a recent increase in trypanosomiasis outside the tsetse areas, and it appears that the problem has been growing with the development of the country and increasing movement and importance of cattle.

The annual reports of the Sudan Veterinary Service contain numerous references to bovine trypanosomiasis, particularly that due to *T. congolense*. The Dinka name for it, *jong alel*, means the sickness of the ironstone country and implies that these swamp-dwellers believe it to originate in the tsetse country south of them. Further north, as far as Kosti and the Gezira (north of 13° and not shown on the map), numerous sporadic outbreaks of trypanosomiasis have occurred, some involving large numbers of animals. According to the veterinary reports much of this could be avoided if the Arab cattle started their northward migration earlier instead of waiting for the new grass to appear. Thus the Humr tribe could save their cattle said to be endangered by a tsetse area on the Bahr el Arab.

It has been found that *G. morsitans* does not spread far from the Koalib Hills in the rains, and Bedford (1936) concluded that other biting flies were responsible for transmission in the surrounding plains.

According to Hoare (1940), Bennet found that in most cases of trypanosomiasis investigated the animals had been in or near tsetse areas.

Buxton (1948, p. 18), discussing the transmission of cattle trypanosomiasis in Africa by flies other than tsetse, referred to a " most striking case " in the Sudan where there is an enormous area with hundreds of thousands of cattle where tsetse are believed not to occur and Tabanidae are abundant in the rains. *T. congolense* is widespread along the Upper Nile in the absence of tsetse and in the 1946-47 season many thousands of cattle died from this infection. *T. congolense* has been found at Kosti, in southern Kordofan and in parts of the Gezira and *T. vivax* is occasionally found.

It would be practically impossible to find out exactly how much trypanosomiasis is acquired in the tsetse areas and how much outside. The country is vast, some tribes wander over great distances which vary with the prevailing conditions, and tsetse areas are not fully

mapped and are subject to fluctuations. It appears, however, that a great many animals become infected beyond the tsetse country.

Contact between tsetse-infected and tsetse-free areas.

It is assumed that trypanosomiasis spreads out of the tsetse areas from time to time and we will briefly consider how this may happen through the movements of animals. Over much of the Sudan there is a tendency for domestic animals, and to some extent game, to move northward each rainy season to find fresh grazing and escape from biting flies, returning southward in the dry season for water and more fresh food. Many comparable movements, but in various directions, occur in relation to rivers, swamps and certain grazing grounds in valleys and around hills.

Animals which are liable to move across the northern limit of *G. morsitans* are cattle which live further north and sometimes enter the tsetse area, cattle which normally live near the tsetse area, such as the Mandari, mentioned by Tothill *at al.* (1948, p. 903), and game animals.

The cattle of the swamp areas usually migrate to local high ground during the rains but in very wet years they may go to the slightly higher ground on the fringe of the tsetse area. Morrice and Winder (1946) reported a seasonal migration from an area south of Renk to the Khor Yabus and upper Khor Adar where tsetse were thought to exist. In times of food shortage cattle owners may take a few animals into tsetse country where they go to fish at Mvolo and similar places. In one such instance it was reported that a witch doctor claimed to protect people against the fly and led them into the infested area.

In the case of the Arab cattle, many travel southward for grass and water in the dry season and some may come into contact with tsetse east and west of the Nile Valley.

Certain cattle-owning tribes living near the tsetse area sometimes go north for grass in the dry season and so may spread trypanosomiasis.

Among migrations of big game the following may be mentioned, although it is not known if they have any relation to trypanosomiasis in cattle. A large-scale migration is known to occur east of the Upper Nile (Bloss, 1945 *b*; Cruickshank and Cave, 1940; Lyth, 1947 *b*; Weeks, 1947; Whalley, 1932). The animals move in vast numbers southward from the swamps and back again but it is not known if many enter tsetse country. Nalder (1936) mentioned a game area between the rivers Naam and Tapari and a northward movement towards the swamps each dry season. Various other movements of game are recorded in official reports (Sudan No. 1).

HUMAN TRYPANOSOMIASIS.

The disease and its control in the past.

The following outline is compiled from the annual reports of the Sudan Medical Service for the years 1925 to 1945, particularly 1929, and from R. G. Anderson (1909 *a*), Balfour *et al.* (1923), Bloss (1945 *a*, *b*), Cantlie (1923), Chalmers and O'Farrel (1914), Cruickshank (1936), Davey (1948), De Pezzei D'Ornella (1947), Drew (1911 *b*), Hunt and Bloss (1945), Hunter (1907), Mackenzie (1911), Mathias (1911), Maurice (1928, 1930 *a*, *b*), Nalder (1936), Ranken (1913), Santandrea (1948), Scott (1939), Stigand (1914, 1923), Soudan Government Gazette (1913), Wilcocks, Corson and Sheppard (1914), Thompson (1911), Worthington (1946) and other authorities mentioned in the list of references.

In general the disease is considered to be caused by *Trypanosoma gambiense*. *T. rhodesiense*, which exists in Uganda, was thought to occur in the Sudan by Archibald (1922) and Archibald and Riding (1926).

From 1903 onwards the Sudan authorities were naturally concerned to prevent sleeping sickness from spreading north, and during the next few years measures were undertaken to prevent its introduction from Uganda, the Belgian Congo and French Equatorial Africa. That the Uganda outbreak with its heavy mortality caused great apprehension is shown, for example, by references to the saving of whole tribes from extinction in the southern Sudan and by the fact that a certain part of the frontier with Uganda was changed to facilitate quarantine regulations (Sudan No. 1, 1927).

In 1909 movements of people were restricted and a cleared isolation camp established in the Raga area.

In 1910 and 1911, 268 cases were detected near Yei where a segregation camp was formed and land cleared against tsetse. The outbreak was controlled by segregation following surveys, and after 1914 the numbers of cases detected in a year never rose above 35.

In 1914 sleeping sickness was detected in the Kajo Kaji district and in 1916, 197 cases were found there and others east of the Nile. Camps were made at Kajo Kaji and Nimule and the disease was completely controlled by 1916, but a few cases have been found since 1934.

Work was started in the Tambura sub-district in 1918. Large numbers of people, scattered in the forest, were concentrated into villages on watershed roads to facilitate inspection and protective clearing and to remove the people from infected fly. Everyone had to live on a road and at least 400 yards from water. In 1920 a settlement for patients and their relatives was started at Li Yubu where the

streams were in due course cleared of small trees. Over 800 cases were segregated in 1923 and probably many more passed undetected. By 1926 the number of detected cases had fallen to less than 100. In the neighbouring district of Yambio villages of about 1000 people were formed near cleared streams but they proved unsatisfactory owing to an increase of house flies and dysentery. The planting of crops in cleared areas was advocated by Archibald (1908).

All this time one of the objects of control was to prevent the disease spreading north along the rivers which were regarded as the most likely path.

By 1937 only a few cases were recorded in the whole Sudan but the policy of settling people away from streams created a new problem. The future of hundreds of thousands of people and the shortage of suitable land had to be considered. Mr. C. B. Symes visited the Sudan to advise on the control of *G. palpalis* with a view to allowing the occupation of riverain land. He reported on the potentialities of a block scheme with hand-catching which was started at Li Yubu in 1938, fly-boys being protected by inoculation (Davey, 1948). The disease was found to exist in the presence of surprisingly few fly, the highest rate of catching being 16 per boy-day. It was found possible to reduce the number of fly very greatly in a few months but not to exterminate it; in 1943 only about five flies were being caught per boy-week. Although people were allowed to leave the watershed roads the disease diminished steadily, but not dramatically.

In 1941 a small epidemic started near Maridi. Fly-catching was started and in one area on the R. Naam, where over 40 flies were caught in an hour, the numbers fell in five months from 209 to less than ten per boy-week. In the main area of infection the number caught per boy-week never exceeded 30. Bloss regarded less than five as a safe figure. Protective rod clearings were made with grass screens at each end. In the Maridi area the chief value of fly control was to reduce the period during which people's movements had to be restricted.

The history of sleeping sickness in the Sudan is largely one of intense effort under very difficult conditions. The measures used have restricted the increase and spread of the disease which is now of little importance; from 1926 to 1945 the average number of detected cases was 66 and the maximum 150. Hunt and Bloss have demonstrated the possibility of controlling outbreaks under local conditions by hand catching of *G. palpalis*.

The present position.

Sleeping sickness and its control have created new problems, one of which is agricultural. Lester (1939) wrote: "The present position

is difficult....the restriction of population along roads limits both the quantity and quality of land available. Since, as far as possible, the roads run along the watersheds there is an increased risk of erosion. In Kajo Kaji district this concentration is affecting the people seriously.... All this seems a high price to pay to prevent possible increases in a mild type of sleeping sickness. In 1938 there were only 105 cases, an infection rate of 0.05 per cent. Even in the peak year it did not reach 1 per cent." In Nigeria an infection rate of one per cent with the mild type of the disease was felt to be of little importance.

The Soil Conservation Committee (1944, pp. 23, 30, 41, 141) found that the watershed roads had enormously increased the erosion problem and even made the provision of domestic water extremely difficult since some populations had been moved to areas with unsuitable soil and inadequate water supplies. The crops have suffered in some places and there is risk of more erosion in the future (Tothill *et al.*, 1948, pp. 588, 591, 900, 906).

The other important indirect effect of sleeping sickness in the Sudan is the expense and loss of time incurred by administrative, medical and public health staff, and the people themselves, in arranging inspections and other measures involved in its control. Nearly half a million gland palpations were carried out in 1945. Fly-catching also requires much organization and supervision. Lester (1939) stressed the importance of controlling other diseases and wrote, of Africa in general, " that there is sometimes a tendency for the occurrence of a few cases of sleeping sickness to be regarded as a calamity."

With regard to economic development it may be noted (Soil Conservation Committee 1944, p. 41) that restrictions have been placed on the development of riverain land.

The present system of control consists mainly of routine medical inspections and the treatment of cases. Many people have been allowed to leave the roads, and tens of thousands have been resettled under the Zande Scheme[1] (Ferguson, 1949). In some areas rod clearings are used to protect villages. In a few others the hand-catching of *G. palpalis* is continued, with the objects of protecting people without destroying timber and of keeping a nucleus of trained staff ready for any emergency.

[1] See article on Zande Resettlement in *Sudan Notes and Records* Vol. XXX (1949) Part I.—*Ed.*

FUTURE CONTROL OF TSETSE FLIES.

The well-tried methods of tsetse control have been fully discussed by Buxton (1948). The problem of control concerns so many authorities that it is a matter for discussion more than hard and fast recommendations, and the following paragraphs are therefore confined to a few remarks. Curd and Dawey (1949) have referred to experiments with new drugs, now in progress in the Sudan, the results of which may have a bearing on the type of fly control required.

Glossina morsitans.

The southern part of the main tsetse area.

Much re-settlement is now in progress in connection with schemes of economic development and soil conservation. It is to be hoped that planned settlement, possibly combined with some discriminative clearing, will be effective in driving game and *G. morsitans* from certain areas. Land occupation sometimes has this result without recourse to special measures, and observations recorded in preceding paragraphs suggest that this may occur in some areas.

The northern part of the main tsetse area.

In much of this region the grass and soil are of poor quality and there is no water in the dry season. Tsetse control therefore depends largely on whether water supplies can be developed. Something might be done however in areas where cattle were formerly kept.

Cattle are sometimes driven south from the great swamps (Bloss, 1945 *b*), and it is interesting to recall the above-mentioned disappearance of tsetse from certain roads and Maurice's (1930) remarks on the arrival of uninfected cattle at Sources Yubu after following inhabited roads from which *G. morsitans* had withdrawn. The need for tsetse-free routes, however, has diminished with developments in protective drugs.

The northern fringe of the tsetse area.

It is presumably from here that trypanosomiasis spreads to the tsetse-free areas, but it is unlikely that any entomological measures can be undertaken to prevent it, apart from providing more information about the distribution of *G. morsitans*.

Glossina palpalis.

Bearing in mind the modern conception of advancing into fly country instead of retreating, it is hoped that much can be done by

using planned settlement to drive out *G. palpalis*. Much land which, as in Uganda (Buxton, 1948, p.12), was justifiably evacuated in the past, can now be protected by known methods. This process might be assisted by the control of *G. morsitans* and the use of some domestic animals to keep riverain vegetation low. In time it might be feasible to drive *G. palpalis* up the rivers towards the south.

Hand catching is useful for dealing rapidly with an epidemic and for continuous control where the nature of riverain trees renders their removal costly or undesirable. A valuable assessment of the method was given by Glasgow and Duffy (1947) who used it to exterminate *G. palpalis* in an area in Kenya. Lester (1939) discussed the Li Yubu scheme and pointed out its value in preserving forest and saving the cost of clearing. He advised that it should be continued and extended but advocated the employment of whole time supervisory staff of a type which would be expensive. Bloss (1945 *b*, pp. 15, 17) emphasized the amount of organization and supervision required, and doubted if tsetse fly control was economically possible in the southern Sudan and if the catching methods employed at Li Yubu were likely to be used elsewhere. He stressed the need for an inexpensive form of local control which could be easily enforced and supervised.

NOTES ON COLLECTING TSETSE FLIES.

Our knowledge of the distribution of tsetse flies is by no means complete, and anyone who is willing to add to it may render a valuable contribution by collecting specimens and sending them for identification. Even unconfirmed reports of tsetse fly are often of interest.

Specimens of the less common species from any new locality would be of interest, and of *G. palpalis* and *G. morsitans* from any area not marked by a point or stroke on Map 4. It is possible that distribution may have changed since the older collections were made. Specimens of *G. morsitans* from any areas marked " G " on the map would give valuable information concerning the problem of trypanosomiasis in the tsetse-free areas. Although *G. tachinoides* is not known to occur in the west it is worth searching for there in suitable localities. If possible male tsetse flies should be sent as well as females. The former may be recognized by a button-like structure beneath the tip of the abdomen, which conceals the external genital organs.

The flies can be found more easily in the rainy season and may be collected in a simple net about 8 inches in diameter and 11 long made with mosquito netting, preferably dyed dark blue, streched over a frame

made by bending a pliable stick and tying the ends to make a handle. *G. morsitans* can often be obtained by stopping a lorry and quickly catching the flies off the back. One should beware, however, of carrying flies far beyond their normal habitat and thus making misleading records. *G. palpalis* and *G. tachinoides* should be looked for along the beds of shady streams, and *G. pallidipes* may be taken on cattle when it does not bite man.

Specimens should be packed dry in small boxes or in tubes stoppered with cotton wool and with a few flakes of naphthalene in the package. Paper or cotton wool wads should be added to prevent shaking. Labels should show the locality (as spelt on official maps, with the latitude and longitude in the case of little-known places), the date and the name of the collector. They may be sent to the Medical Entomologist, Wad Medani, or any other entomologist.

The following key (adapted from Smart, 1944) will enable one to make a provisional determination of the Sudan species in the field :—

1. Apical two hind tarsal segments dark brown or blackish, the basal three hind tarsal segments being paler 2
   All segments of the hind tarsi mainly dark brown or blackish when viewed from above 6
2. Small species, under 11 mm. in length (excluding proboscis and wing tips) 3
   Larger species, usually over 11 mm. in length 4
3. Abdomen pale brown with ill-defined dark bands (in Sudan specimens seen hitherto) .. .. *..pallidipes*
   Abdomen with well-defined dark and pale bands .. *..morsitans* or subspecies
4. A light yellow-brown species .. .. *longipennis*
   A dark brown or gray species 5
5. Sides of thorax blackish, infra-alar bulla dark brown .. *fuscipleuris*
   Sides of thorax relatively pale, infra-alar bulla yellow .. *fusca*
6. Dorsal surfaces of the abdominal segments light yellow in ground colour, with sharply defined dark brown interrupted transverse bands anteriorly ; 6.5-9 mm. long .. *..tachinoides*
   Dorsal surfaces of the abdominal segments with narrow pale hind margins and with an ill-defined longitudinal mark only slightly paler than the general brown colour ; 8-11 mm. *palpalis* ssp. *fuscipes*

SUMMARY.

The paper is based mainly on published information and is presented as a survey of past experience and of the present position in the Sudan. It is intended to facilitate the adoption of new measures in the light of modern knowledge.

The history of tsetse surveys in the Sudan is reviewed.

Our local knowledge, mainly of distribution, of the seven species which occur is recounted,

Some aspects of distribution are discussed.

The problems of bovine trypanosomiasis and human sleeping sickness and the control of the latter are briefly described.

A section on future control measures is confined to a few remarks, because decisions can only be made as a result of discussions between the various interested authorities.

Notes are given on collecting specimens for the purpose of increasing our knowledge of distribution.

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THE EXCAVATION OF A NEOLITHIC SITE AT ESH SHAHEINAB.

By A. J. Arkell.

(Based on a paper read before Section H of the British Association at Newcastle on 2nd September 1949).

An early occupation site at Esh Shaheinab on the west bank of the Nile about 30 miles north of Omdurman was excavated under the auspices of the Sudan Government Antiquities Service in January 1949. This site is one of a number between Jebel Aulia and the Sixth Cataract on which stone gouges typical of the Fayum Neolithic had been found associated with burnished and incised sherds.[1] The site at Shaheinab consists of a low straggling mound about 200 metres long and nowhere more than 30 metres wide, on a broken gravel ridge that represents the neolithic bank of the Nile, about half a mile west of the modern river bank.[2] At high flood the river comes over its modern bank. The top of the old river bank, on which the site is situated, is approximately 4.5 metres above the highest recently recorded flood (September 1946). It has suffered considerable erosion particularly on the east side where it slopes towards the Nile, and from the fact that graves dating from both the Protodynastic (c. 3000 B.C.) and Meroitic (c. 100 B.C.—100 A.D.) periods were found at the present surface of the ground in this area, it seems that most of the erosion has occurred in the last two thousand years.

The debris left by the early occupation is nowhere quite one metre thick today.[3] Although the site was chosen because it appeared on the surface to have been less disturbed than other sites of the same culture, it was found to have been used as a cemetery at four different periods, Protodynastic, Meroitic, probably medieval Christian, and Muslim.

The Protodynastic graves contained contracted negroid skeletons, and their dating is based on pots with horizontal rippling which occurred in some of them, (see *Early Khartoum*, Plate 93, figs. 1-3). Pots and bones in the Protodynastic graves were frequently covered with kankar,

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[1] A. J. Arkell, *Early Khartoum*, London 1949. Plate 88. For ease of reading the article *Esh* will be omitted.

[2] Pl. I (top). [3] Pl. I (bottom).

indicating that the water-table was still almost as high during part of the year in 3000 B.C. as it had been at the time of the neolithic settlement. For, as at Khartoum, bone objects in the debris of the settlement were preserved by the kankar deposited on them when the water-table, dependent on the river, fell away during the dry period of the year.

Only six weeks were available for the excavation ; so four trenches each three metres wide were cut across the site from east to west, one near each end of the site and two in between ; and then, the northernmost trench showing least disturbance, it was extended to the north, in the hope of finding a contemporary burial. But habits had changed since the times of early Khartoum, where the dead were buried in the occupation site, and it is doubtful whether any such burial was found, the only possible one being that of a negroid child.

No traces of human habitations occurred—not even a little burnt mud from wattle and daub as at Khartoum—and the houses must have been flimsy constructions of grass ; but much more use was made of fire for cooking than at Khartoum. Numerous hearths were found, some paved with small lumps of sandstone, and mostly containing sherds, bone fragments, shells and artifacts ; and where these hearths were situated at the bottom of the occupation debris on the surface of the black alluvial clay that formed the natural soil, there was often a shallow oval hole made in the natural soil, making it permissible to compare these hearths with the fire-holes characteristic of the Fayum Neolithic.

Except where hearths occurred there was no obvious stratification ; and the method of excavation was to remove all obviously disturbed soil, and then to excavate by conventional layers the soil that was apparently undisturbed.

Thousands of sherds were found, but not a single complete contemporary pot. A few sherds of the Dotted Wavy Line ware (see *Early Khartoum*, Plate 72) were found, usually near the bottom of the occupation debris. This ware is decorated with a pattern of five or six wavy lines, on which dots have been superimposed, alternating with five or six straight lines of dots. It is unburnished and the pattern is impressed ; it is the most developed form of the mesolithic pottery decorated with this characteristic wavy line form.

A number of sherds of a different type were also found. These were burnished and decorated with a pattern of impressed dots in alternating series of wavy and straight lines. They were therefore intermediate between those already described and the burnished ware which is characteristic of the " Gouge Culture " sites, and which is

illustrated in plate 88 of *Early Khartoum*. This presumably later ware has a pattern consisting of bands of small cuneiform impressions alternating with several rows of smaller circular impressed dots.[1]

This kind of decoration seems to have been used on large pots usually at least 40 cm. in both height and diameter. The other characteristic decoration of fine parallel incised lines (sometimes lines of fine dots) was used on smaller bowls, and was derived from the thin brown ware with lines of incised dots (*Early Khartoum*, plates 83, 84) of the culture of early Khartoum. Some sherds from these smaller bowls show the incipient development of panels of decoration that could easily grow into the pattern characteristic of the Pan Grave ware. Another development of the " Gouge Culture " pottery was in the rim—while the rims from early Khartoum are all very simple, being slightly thinner than the rest of the pot, some of the " Gouge Culture " rims are markedly thicker than the rest of the pot, and some are flattened on top as well.

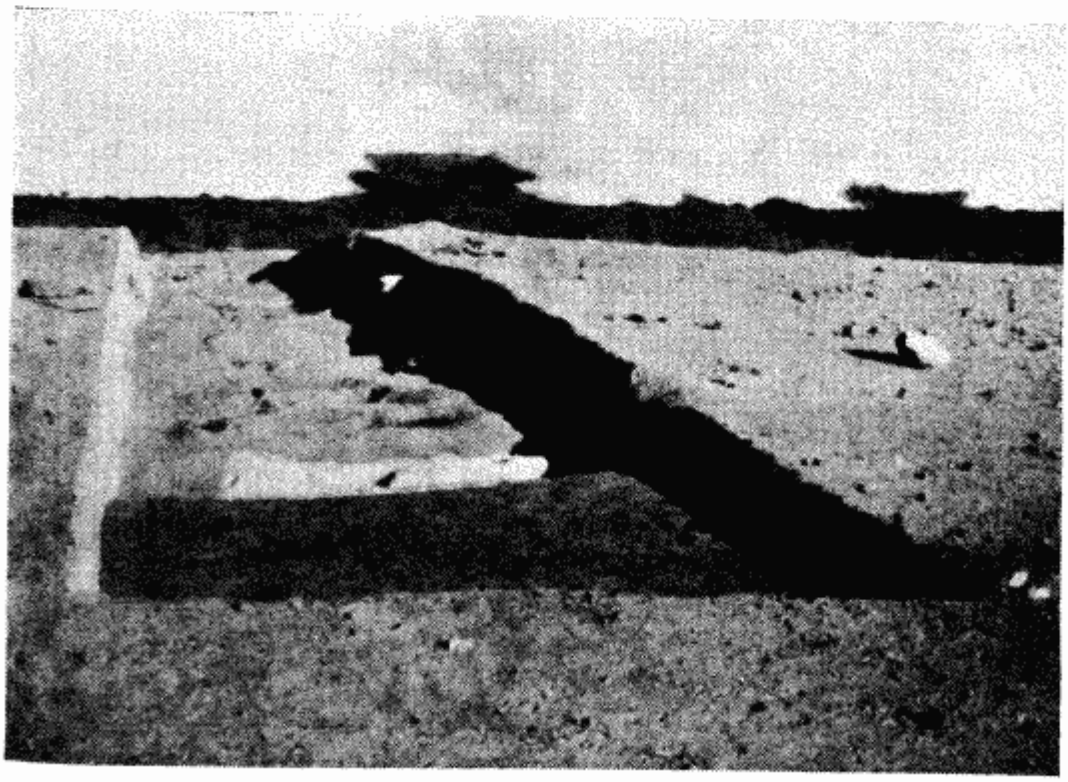
We have seen that the introduction of burnishing was a feature of the " Gouge Culture." Some of the sherds were burnished after the decoration had been incised on them, and though no sherd has yet been noticed where intensification of the burnishing produced the rippling characteristic of the Badarian and of the Sudan Protodynastic, it might have been produced at any moment.

Other " Gouge Culture " pottery patterns include straight-combed exteriors, various wedge-shaped impressions, and zig-zags of impressed dots. Plain black burnished ware occurs, and blackish grey ware with red slip to within 10 mm. of the rim, also a red burnished ware with a blackened rim. There are also a number of thin sherds with a finely incised pattern on the black rim. They are coated with red slip, which ends a few millimetres below the rim on the outside in a dog-tooth pattern of alternate red and black triangles, apparently produced by painting with red slip after blackening the rim, and then partly scraping the red slip off again. Secondary firing is suspected. Though such a developed ware, there is no doubt that it is contemporary with at least the later phases of the occupation, and it is presumably an early stage of the black-topped red pottery, destined to develop later into the wares characteristic of Badarian and the Early Predynastic. Another probable link with the Early Predynastic of Egypt was the flat-topped granite macehead, apparently made locally from a granite ochre-grinder, of which a few examples occurred, although most of the ochre-grinders were of sandstone. One complete macehead was found in three pieces[2] (besides a number of other fragments); it is similar in shape to an

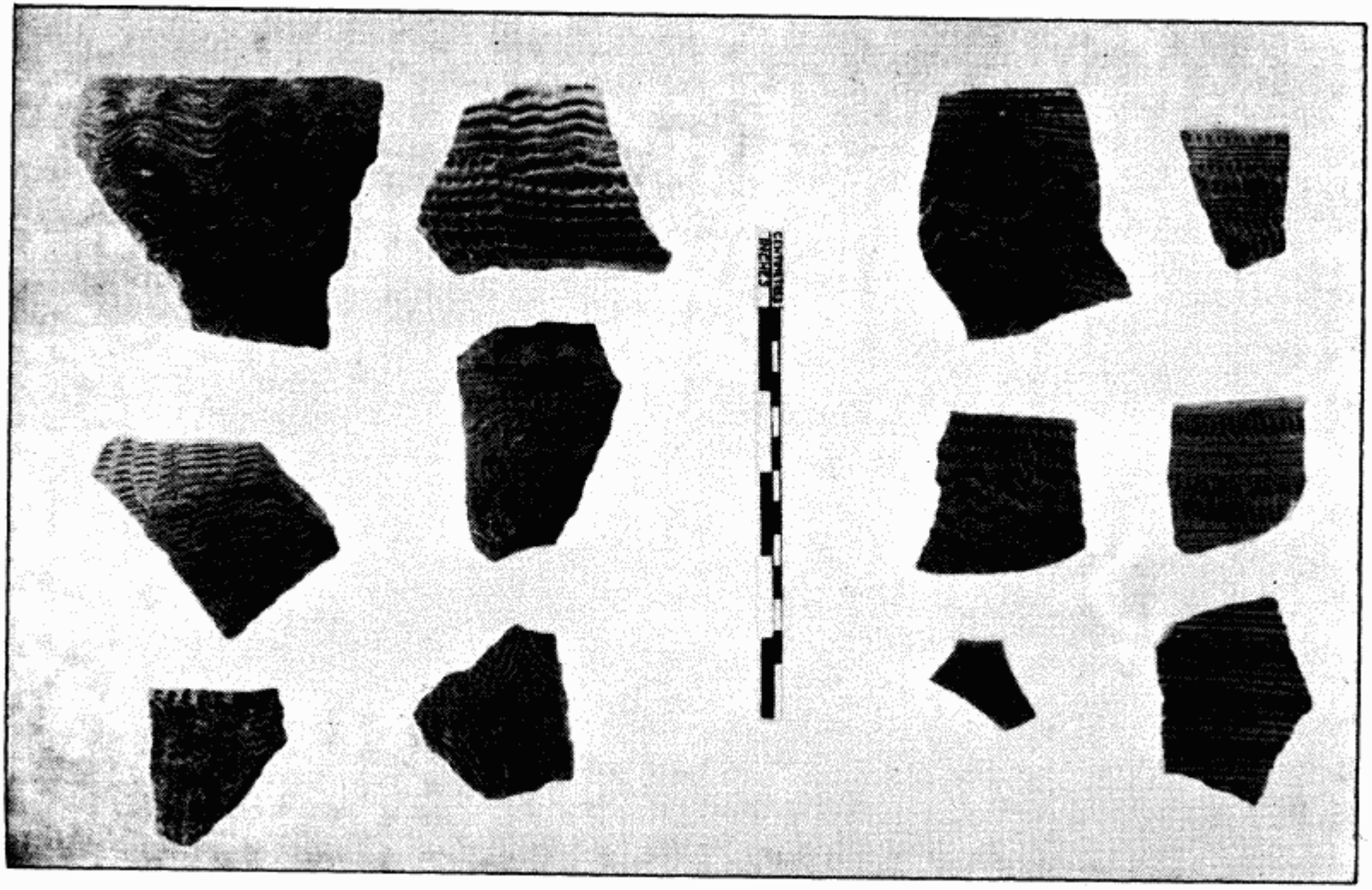
[1] Pl. II. [2] Pl. IV (top)



Esh Shaheinab during the excavation. Looking north along the neolithic river bank on which the site is situated.

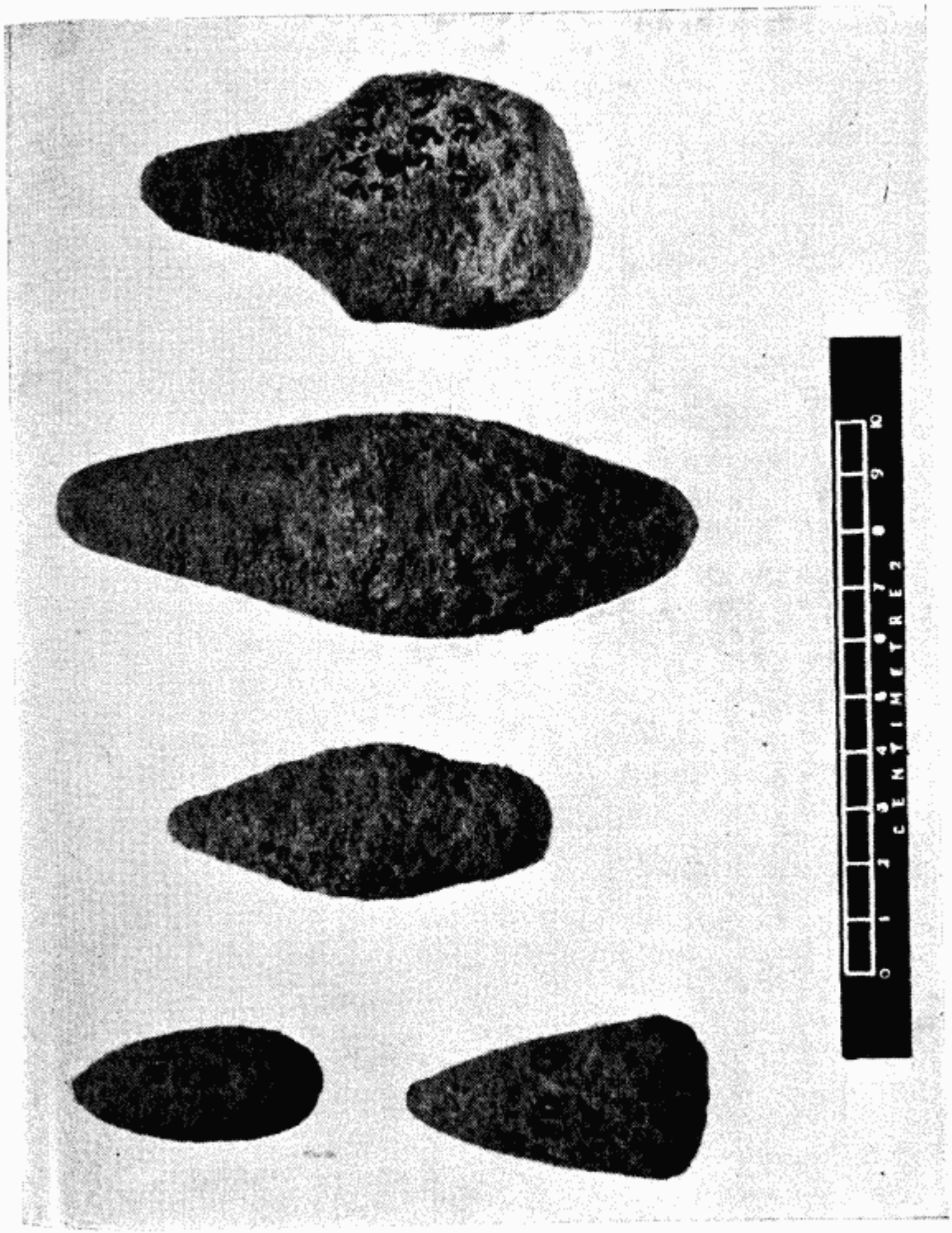


Trench cut through the occupation debris down to the black alluvial soil of the neolithic river bank on which the Gouge people settled. Looking east towards the modern Nile.

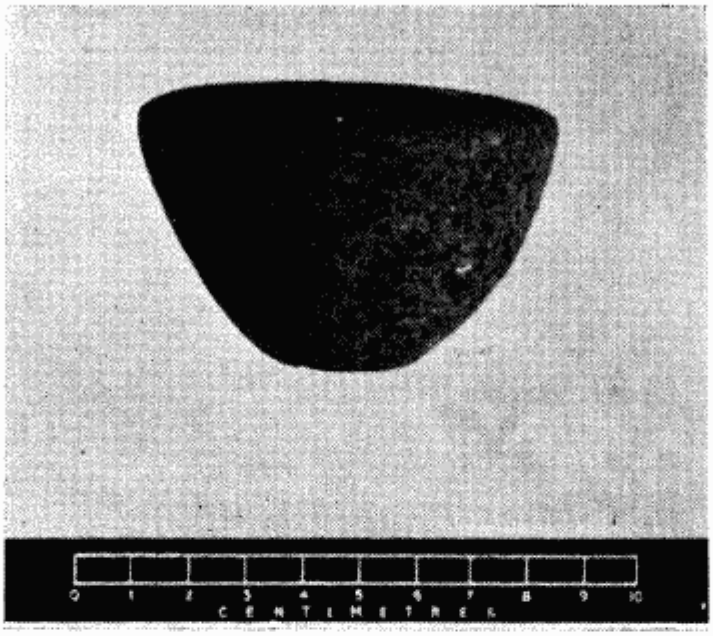


Sherds from Early Khartoum (*to left of scale*) and from Esh Shaheinab (*to right of scale*) arranged to show presumed development of design.

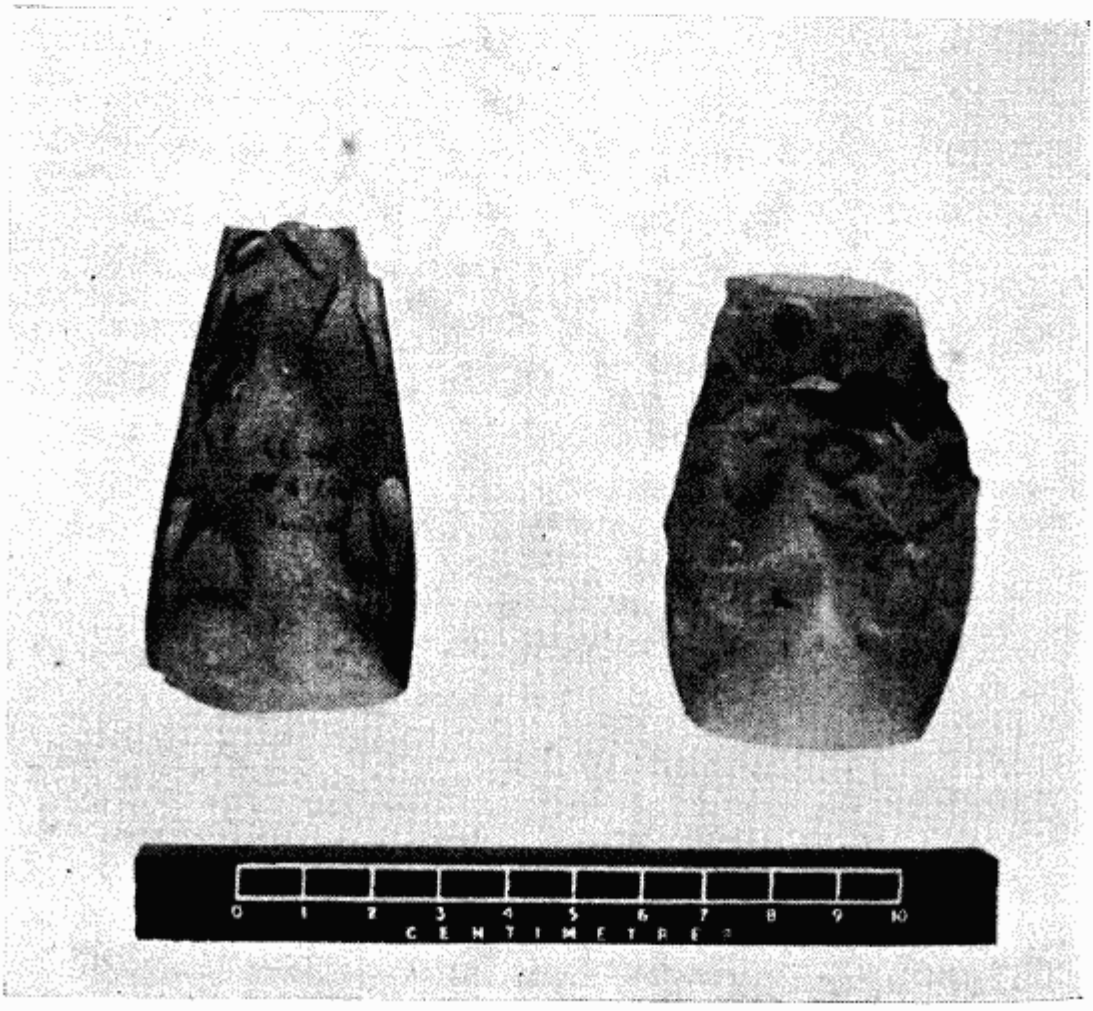
PLATE II



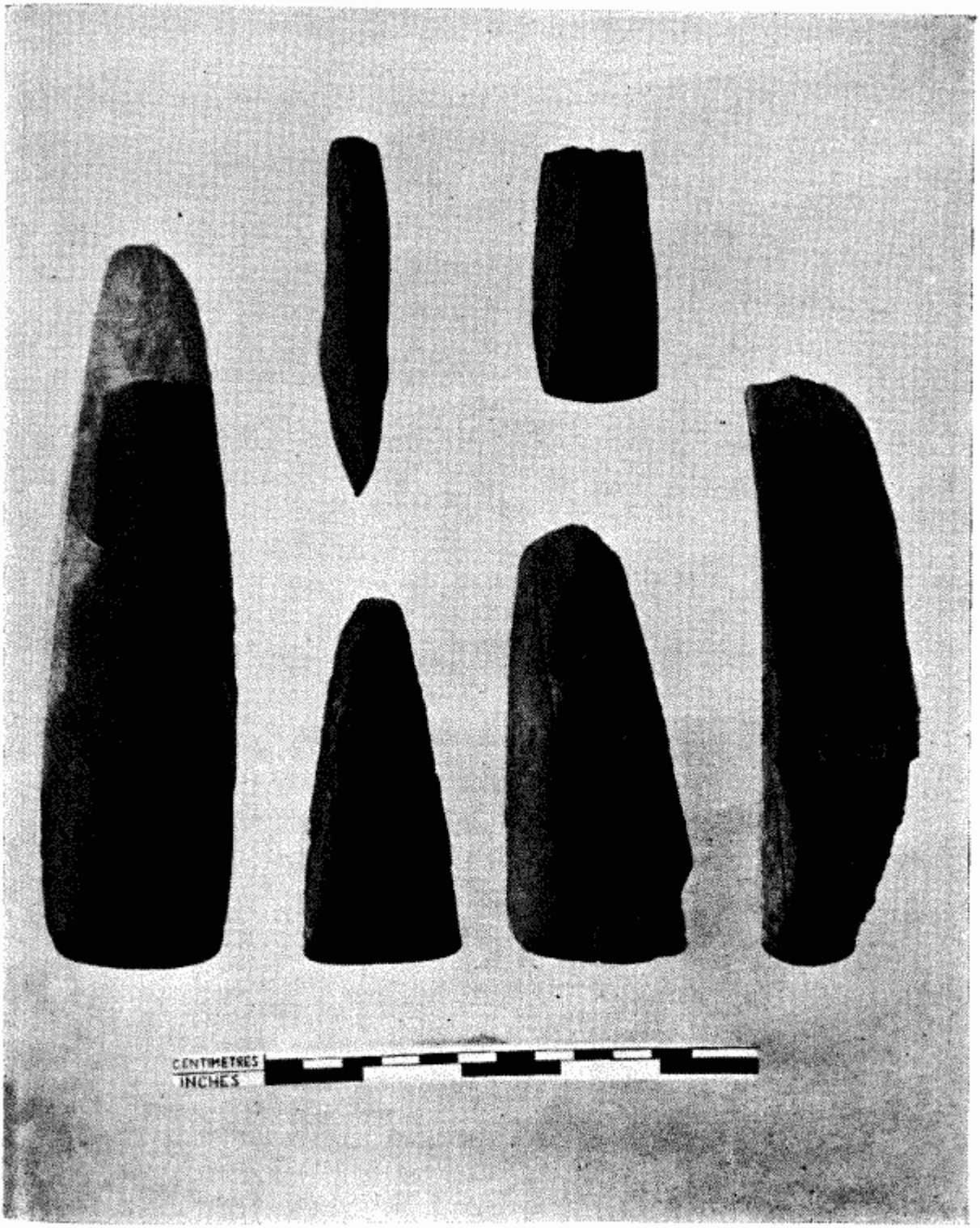
Sandstone rubbers from Esh Shaheinab.



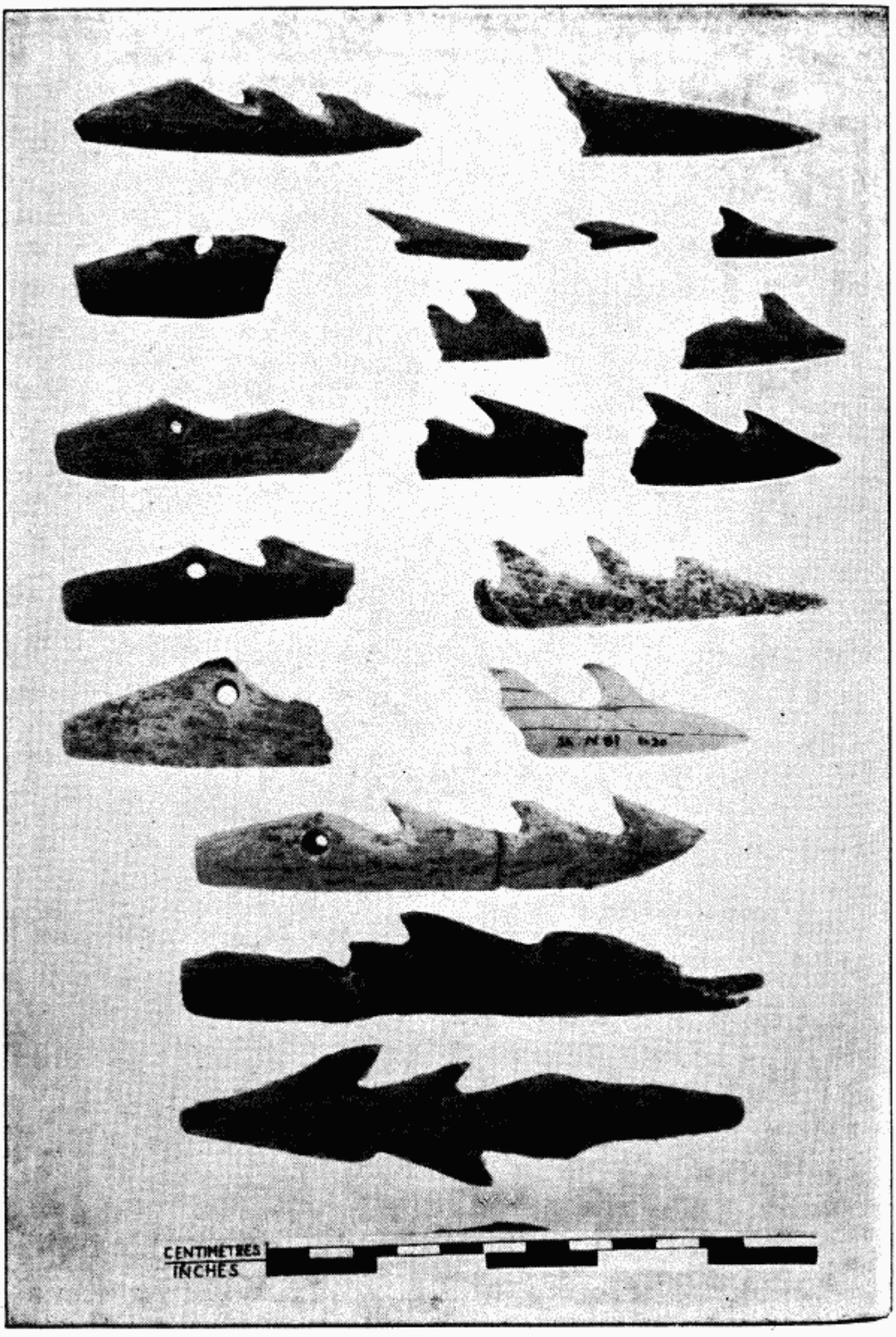
Granite macehead from Esh Shaheinab.



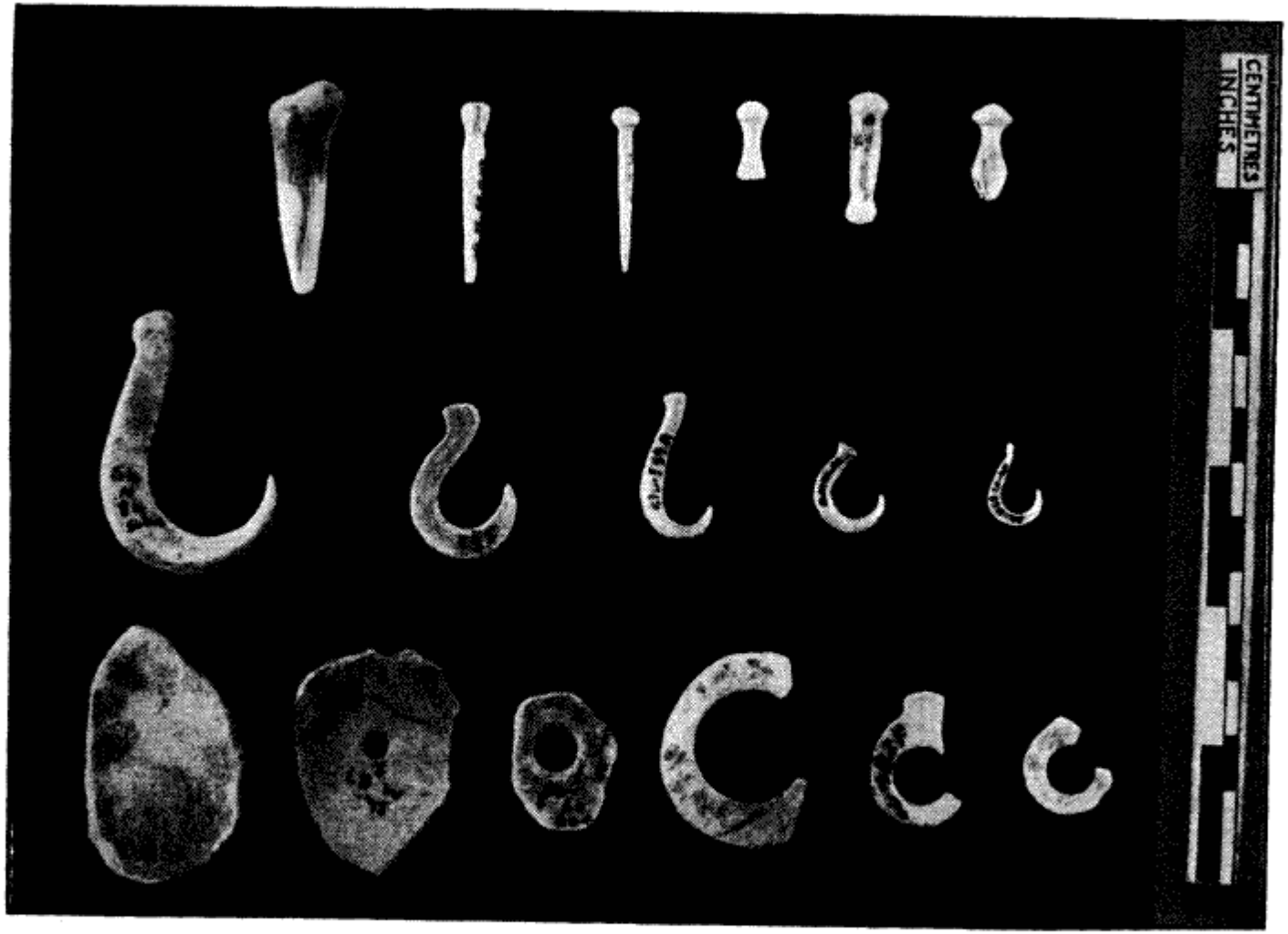
Chipped and partly polished rhyolite axeheads from Esh Shaheinab.



Bone axeheads from Esh Shaheinab.



Bone harpoons from Esh Shaheinab.



Unworked zeolite and five pins made from zeolite (*top*).
Fishhooks made of shell (*centre*).
Stages in the making of a shell fish hook (*bottom*).

PLATE VII

alabaster example figured by Petrie in *Prehistoric Egypt* Plate 36, fig. 51, of which the date and provenance are unknown. Two or three fragments of disk maceheads were also found at Shaheinab, similar fragments having been found on other sites of this culture.

The sandstone artifacts seem to show a natural development from the ochre-grinders and rubbers of early Khartoum. The grooved "fishing-line sinkers" and half rings of sandstone do not occur, and pitting of the surface of the ochre-grinders is much rarer and never more than slight. On the other hand ochre-grinders with a definite wide shallow concavity on one side, presumably used as palettes for mixing powdered ochre with grease, are commoner and more developed. One such palette had apparently a lug for suspension; and in general these palettes may well have been the forerunners of the Predynastic palette, which was often notched for suspension. Ochre-grinders without this marked concavity tend to be flat on one side and uneven on the other, or are flat on both sides, and then frequently circular or oval in shape. A number of cylindrical stone rubbers taper at either one or both ends, and were probably used for making shell fish-hooks and for working bone and ivory.[1]

As at Khartoum the larger stone tools at Shaheinab were made of rhyolite from the Sixth Cataract, while quartz pebbles, chert, etc., were used for the microliths. The relation of some of the stone tools to the Fayum Neolithic and the Neolithic of Ténéré (*L'Anthropologie*, 1, pp. 325-330) is obvious. At Shaheinab much the most numerous tool was the gouge, in which a certain amount of polishing on the underside seems reasonably accounted for by wear. These gouges must have been used for working wood, probably chiefly in making dug-out canoes, like those still used on the White Nile today. Some form of simple boat such as a dug-out must have been essential to a people who spent much of their life on the river, hunting water-animals, collecting water molluscs and fishing. And there must have been much coming and going across the river, for there are sites of the same culture on the east bank of the Nile, one being almost opposite Shaheinab.

If the gouges were the most numerous, the axes were the most interesting. Indeed the excavation has thrown important light on the development of the axe. Eleven partly polished axeheads made from the long bones of large mammals, and 65 fragments of these tools, were found with a similar number of stone axeheads. Both forms of axe-head were contemporary, specimens of each occurring together in the same hearth. The bone axeheads vary in length from 194 to 66 mm.,

[1] Pl. IV.

and in maximum width from 70 to 33 mm., the average length being 131 mm. and the average maximum width 43 mm. They have been narrowed to a rough tang at the butt end, no doubt for insertion into a wooden handle, and have been given a sharp cutting edge at the broad end by being rubbed, presumably on sandstone.[1] Though generally smaller than the bone axehead, some of the stone axeheads were the same size as bone specimens. Some had been only chipped, (and among these are probably to be included the tools similar to the so-called "chisels" of the Fayum Neolithic), but others had been polished by rubbing at the cutting end, to an extent similar to the rubbing on the bone axeheads.[2]

It is difficult to avoid the conclusion that the bone axeheads are the prototype of the polished stone axeheads. The inhabitants of the site appear from the animal remains to have hunted large animals which included hippopotamus, rhinoceros and elephant. Probably large splinters of bone had been used since palaeolithic times for hacking meat off the kill, the next step being to fit such a splinter into a wooden handle and thereby to make a more efficient hacking tool. It would not be a difficult further step, for people who were using sandstone grinders for ochre, to give the tool a sharp edge on a sandstone rubber. Having thus invented the axe, they probably transferred its use from meat to wood, on which as we have seen their gouges must have been used; and when they found a bone axehead was not strong enough to cut any but the softest woods, it would be an easy step for them to copy the bone axehead in stone, and so the chipped and partly polished axehead would be invented.

The so-called "chisels," which we have already mentioned as being possibly a form of axehead, occur in the Fayum Neolithic and at Ténéré as well as at our site, as do what were described from the Fayum as "planes" and may be a rough form of gouge. Scrapers are not unlike those from Ténéré. Trihedral borers are common to all the three sites, but a more frequent form of borer at Shaheinab was one in which two sides of a small thick flake are partially trimmed on either side at one end, a broad flat piece of the flake being left rough at the other end as a handle. Slug borers of Wilton type also occur.

The complete absence of the tanged and recessed base arrowheads which occur both in the Fayum and at Ténéré must be important, if only the reason for it can be grasped. At Shaheinab the thousands of microlithic crescents which occur must have been used for Capsian-type arrowheads and barbs. The trapezoid chisel-type arrowheads, of which a few were found at early Khartoum, are completely absent.

[1] Pl. V. [2] Pl. IV (bottom).

The small stone borers were used for making beads among other things. Many disk beads of ostrich egg-shell, some of them burnt black, were made on the site, for unfinished beads were found and fragments of ostrich egg-shell plentiful. Small disk beads of blue-green amazon-stone (microcline felspar) were also made on the site, five complete beads and a few fragments, some only partially bored, were found, with many small fragments of unworked amazon-stone. The nearest known sources for amazon-stone are the Eghei Mountains north of Tibesti, and J. Migif in the eastern desert in Egypt. Beads of this material occurred in the Fayum Neolithic.

Teeth and small tusks were occasionally perforated and used for personal decoration, also pendants of stone, of ostrich egg-shell (sometimes decorated with incised lines), and of mollusc shell. Shells of the land snail *Limicolaria*, and shells of fresh-water bivalves were perforated and presumably worn. A pebble of zeolite, said by the Government Geologist to have originated in Abyssinia and possibly to have come from Blue Nile gravel, had been partially perforated for use as a pendant. Many of these zeolites were found unworked on the site, and some partly worked, also 23 pins of varying shape manufactured from them by rubbing.[1] Twelve similar pins, the longest 38 mm. long and looking like a modern wire nail, were made of bone. Presumably these were worn as plugs in the lip, nostril or lobe of the ear. One slender quartz lip-plug was also found, and several unworked quartz crystals.

Bone axeheads have already been mentioned; of other bone artifacts the most important were the bone harpoons, of which several fragments but no complete example were found.[2] The type of harpoon usual at Shaheinab has a flattish cross-section, at least three barbs on one side, and a hole bored from either side through the upper anterior part of the broad butt. This hole was a weak point in the weapon, for a number of examples are broken through the hole. The closest parallels to this type of harpoon at present seem to come from the southern Sahara (Tamaya Mellet[3] and Guir[4]) and not from the Nile Valley. No barbed bone spears of circular cross-section with grooved butts, such as were typical of early Khartoum, were found, but there was one example of an almost complete spear (or harpoon) with two barbs on either side of an almost cylindrical shaft with a prominent bulb behind the barbs.[5] This bulb was presumably for the attachment of a line,

[1] Pl. VII (top). [2] Pl. VI.

[3] See Harper Kelley in the *Journal des Africanistes*, iv, Pl. ix, 8.

[4] See M. F. Roman, 'Sur une faunule de vertébrés et des pièces néolithiques du Sahara occidental' in the *Bulletin de l'Association Régionale de Paléontologie et de Préhistoire*, No. 5, Pl. 1, figs. 3-9. Lyon 1935.

[5] Pl. VI (bottom).

and if so the weapon was a harpoon. It is 133 mm. long and reminiscent of the Upper Magdalenian, although a small example of this type with only one barb was found in the Fayum (*The Desert Fayum*, Plate 47, fig. 24). Other objects of worked bone include bone awls, burnishers, and the metapodials of small antelopes cut obliquely. The purpose of the last is uncertain. They have clearly been worn with use where cut obliquely. Could they have been filled with powdered ochre and grease, for use as a kind of crayon, or were they used for burnishing pottery ?

Some Nile Oyster shells had their lips rubbed down to improve their shape, and were then no doubt used as ladles—thus they may be the prototype of the spoon. The shells of the Nile Oyster and of the large bivalve *Aspatharia* were also used for the manufacture of barbless fish-hooks. Thirty two complete fish-hooks besides a number of fragments were found, varying in length from 49 to 14.5 mm. and in width from 33 to 10 mm.[1] Many fragments of cut shell and a number of partly finished fish-hooks make it possible to deduce the method by which these fish-hooks were made. Oval blanks of shell were first bored with a small hole of about 3 mm. in diameter, and the hole was then enlarged to about 9 mm. in diameter. After that a piece was broken out of the circumference of the rough circle of shell so formed, and then the notched head was made for the attachment of the line.[2] The hook was then completed by having its other end rubbed into a point. All Badarian fish-hooks of shell were bored for the attachment of the line. This is thought to be a later development than the notch, for it must have been impossible to perforate a small shell fish-hook without a metal borer. Two small notched fish-hooks of ivory are known from the Badarian, and notched fish-hooks of bone occur in the Natufian and the Maglemose cultures.

A few bivalve shells had had their edges purposely serrated. These were also found in the Fayum Neolithic, at Merimda and on the Wadi Ghuzzeh (*Bethpelet II*) in S. Palestine. Miss Caton-Thompson suggests that they were used for skinning fish. At Shaheinab they were certainly purposive, for one example shows wear. Another possible use may have been for the decoration of pottery ; for with them could be formed the zigzag patterns of curved dotted lines which it would be difficult to make in any other way. Several rhyolite flakes seem to have one edge purposely serrated in a rough way.

No evidence of cultivation was found. As at early Khartoum the only seeds are those of the *Celtis* tree, except for one carbonized fragment said to agree exactly with specimens of the shell of the African oil palm (*Elaeis guineensis*) in the collection of the Royal

[1] Pl. VII (centre). [2] Pl. VII (bottom).

Botanic Gardens at Kew. This palm has a wide range, and apart from West Africa occurs in the Ubangi-Shari-Chad region, Uganda and the Upper White Nile. Broun and Massey in *Flora of the Sudan* p. 403 state that at Wau and in the latter locality it is not native. Kew suggest that since the fruit of this palm is important economically on account of the oily pericarp and the oleaginous kernel specimens may be carried outside the natural habitat of the palm by human agency. The possibility of this specimen having been brought from the Chad area is interesting.

We have already noticed that the inhabitants were largely hunters and fishers. Many fragments of mammal bone and teeth from the site are now being studied by Miss Dorothea M. A. Bate, who in addition to the animals mentioned, has already recognized giraffe, buffalo, antelope, warthog, porcupine, grivet monkey, several carnivores including hyaena, python, crocodile, monitor lizard, river turtle and several kinds of Nile fish. We have also at Shaheinab the earliest known domestication of animals in the Sudan: there are a number of remains of a dwarf goat and probably of another species of goat, also possibly a sheep and probably a domesticated dog.

A few days spent at El Qoz on the southern edge of Khartoum, a site where both cultures occur, demonstrated stratigraphically that the culture of Shaheinab (previously called the "Gouge Culture") is later than the culture of early Khartoum, (previously called the "Wavy Line Culture"). Such a demonstration was hardly necessary in view of the evidence of the pottery of the two sites, but it is reassuring. It is for this reason that I am inclined to abandon these names, and to call the earlier culture the Khartoum Mesolithic and the later the Khartoum Neolithic. The former culture is particularly associated with Khartoum, having been first studied there, although it is found also at considerable distances from Khartoum; the latter is at present confined to the Khartoum area. I use the term "Mesolithic" in the sense used by J. G. D. Clark in his *Mesolithic Settlement of Northern Europe*, where nothing more is implied by it than that it flourished in the main in point of time between the Palaeolithic and the Neolithic, and it was applied to food-gathering cultures (hunters, fishers and collectors) one at least of which had pots with pointed bases. And though there is no evidence of agriculture, the polished axe had been invented and the domestication of animals commenced at Shaheinab, while there are indeed several other links with the Fayum Neolithic.

It may be thought that Shaheinab, with its maceheads and fragmentary disk maceheads, is only contemporary with the Early

Predynastic of Egypt. But although negative evidence is always unreliable, there are so many things absent at Shaheinab that one would expect to be present if it was an off-shoot of the Early Predynastic, among them being glazed steatite beads and blue faience beads, a few of which are almost certain to have travelled up the Nile and reached the Khartoum area by way of trade, if things like disk maceheads did. Stone arrowheads with recessed bases or tangs and small copper objects such as awls might also have been expected. But they are all absent, and we have seen that the maceheads probably developed locally from granite ochre-grinders—and if the ordinary maceheads, why not the disk maceheads ?—while the shell fish-hooks are slightly more primitive in type than the fish-hooks of the Badarian, which preceded the Early Predynastic. It is indeed a puzzle how the maceheads missed the Badarian, but if we knew what these " maceheads " were really used for, it would be easier to assess their absence. There is however, as we have seen, much at Shaheinab that is common to the Fayum Neolithic. There seems therefore to be sufficient evidence to render it probable that the Fayum Neolithic (and with it the Khartoum Neolithic which seems probably to be slightly earlier than the Fayum Neolithic) is, as its finder considered, earlier than the Early Predynastic, and not contemporary with it, as Dr. Baumgartel has argued recently in her book *The Cultures of Prehistoric Egypt*. The amazon-stone beads suggest connections with the Fayum, and the amazon-stone outcrop at Eghei in the Tibesti area is one of the only two possible localities known for amazon-stone. The bone harpoons too are closer in style to those from sites in the southern Sahara than to those of the Egyptian Predynastic. In short the finds at Shaheinab suggest a culture connected more closely with the west than with the Egyptian Predynastic. In *Early Khartoum* I have suggested that there is considerable evidence that the desert then did not come as far south as it does now, and that anyhow along the watercourses in the country stretching 2000 miles west of Khartoum there was nothing to stop the east-west migration of man and animals. It seems likely therefore that some of the elements in the embryo civilization of early Khartoum may have come from steppe lands to the west. If they were at that time beginning to dry up, as is probable, the direction of movement is much more likely to have been towards the Nile Valley with its permanent water supply than away from that valley towards the desiccating west, as is the accepted view at present, particularly of M. Vaufrey and other French prehistorians. Shaheinab offers, however, a riddle of its own. How is it that we have related cultures as widely separated from each other as the Fayum, Khartoum and Ténéré ?

At first I thought that there must have been two movements from Ténéré, one north of the Libyan desert to the Fayum, and the other south of the Libyan desert to the Khartoum area. But the absence of the developed arrowheads from the Khartoum area makes that view untenable. It looks as if the new cultural influences that came to the Khartoum area to form the Khartoum Neolithic must have left the dispersal area before those that reached the Fayum and Ténéré left it. Where was that dispersal area ? I suggest that it may have been the country around Tibesti. We have seen that one of the two known sources for amazon-stone is in that area. Archaeologists should turn their attention to Tibesti. That the search will not be unfruitful is indicated by the publication of gouges from Emi Zeridé near Bilma by P. Noel (*L'Anthropologie*, xxviii [1917], pp. 351 - 368), gouges from Erassou (west of Gouro in south-eastern Tibesti) by Dalloni (*Mémoire de l'Académie des Sciences de l'Institut de France* 62 [1936] p. 183 (fig. 60) and p. 185), and sherds from various sites in the Tibesti area (*loc. cit.* p. 205, fig. 73, especially *g*, *k*, *n*, *o*, and *p*) ; and sherds from Enneri Tidedi in north-eastern Tibesti by Ardito Desio in *Il Tibesti Nord-Oriental* Pl. XXVIII. (Rome. ? 1942).

BUTTERFLIES OF THE NORTHERN AND CENTRAL SUDAN

By C. E. Wilson.

INTRODUCTION.

This article has been compiled to meet the needs of those officials and others who have an interest in the butterflies they see about them, but who have so far not had any convenient work of reference to enable them to identify even the commonest species. A knowledge of the English Butterflies is of no use in this country, as only two species occur here that also reach England, and only one, the " Painted Lady," can be said to be common in both countries.

The framework of this article, and the notes on coloration, etc., are based on a very instructive paper by A. J. Wiley and J. R. Hudson which was published in the *Journal* of the East Africa Natural History Society in September 1943, and the classification used by them is followed. The species dealt with, however, differ considerably from those described in this article, all of them being butterflies of the Nairobi district. Use has also been made of a series of papers by Dr. Van Someren, on the Butterflies of Kenya and Uganda, which appeared in the same periodical.

The identifications of the species have been obtained from various sources, but mainly from specimens in the collection of the Research Division of the Ministry of Agriculture and Forests at Wad Medani, which have been identified at the Commonwealth Institute of Entomology in London. As only a few species which occur in the Sudan have English names, these have been ignored, and the correct scientific names have been used throughout. Some of the names used may have been revised by more recent work, but they will serve as a satisfactory basis of classification.

This article, of course, does not include all the butterflies to be met with in this area, but should be found to contain all those normally encountered.

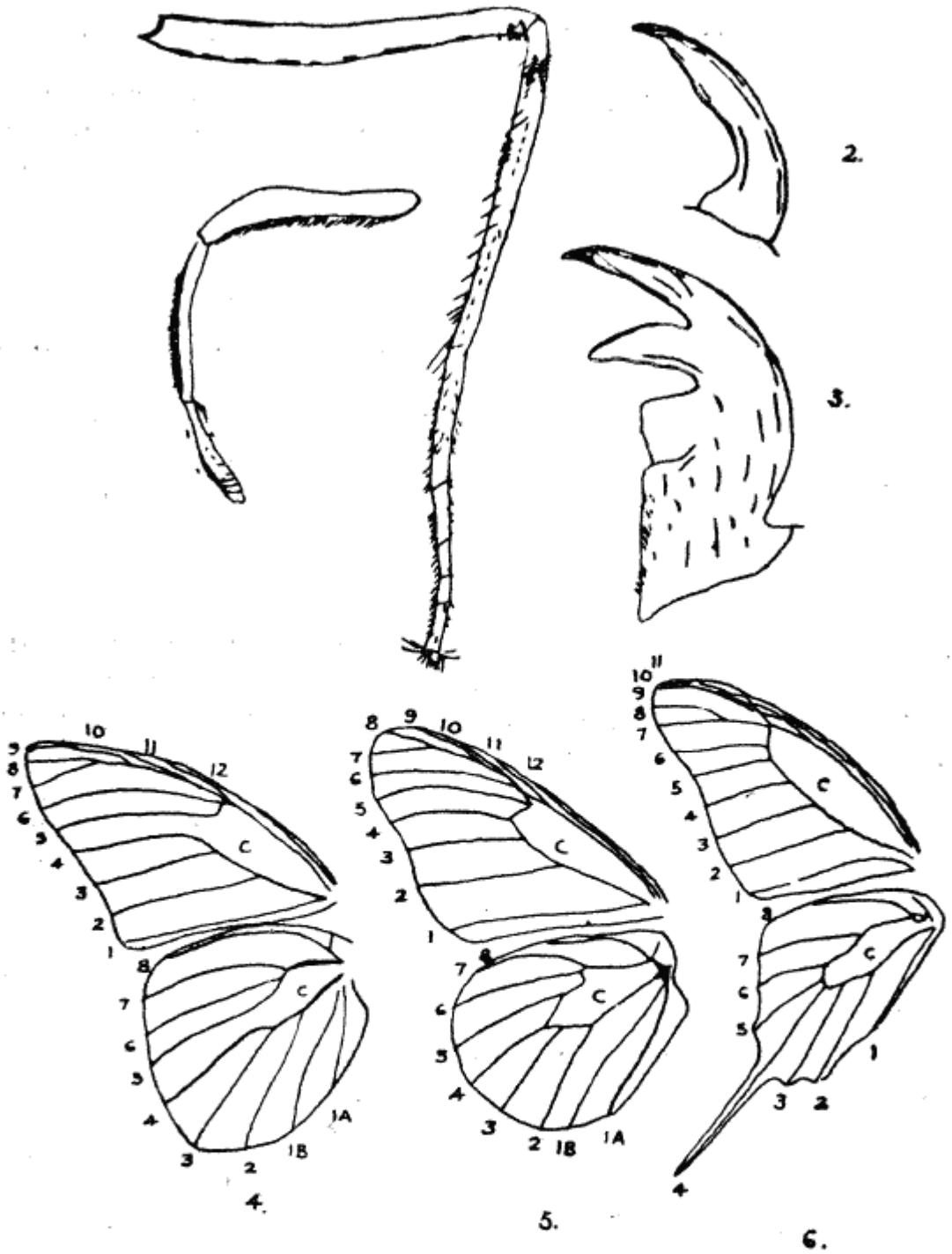


PLATE I.

Fig. 1. Foreleg (on left) and midleg (on right) of *Hypolimnas misippus* F. drawn to the same scale to show the greatly reduced foreleg in the *Nymphalidae*.

Figs. 2-3. Single claw of *Papilio nireus* M. *Papilionidae* and bifid claw of *Colitis antevippe* F. *Pieridae* (not to scale).

Figs. 4-6. Diagrams of wing venation. The numbers are those used in referring to the veins. The discoidal cells are marked " C."

Fig. 4. *Hypolimnas misippus* F. to show the open discoidal cell of the *Nymphalidae*.

Fig. 5. *Danaus chrysippus* M. to show the closed cell of the *Danaidae*.

Fig. 6. *Papilio porthaon* Hew. to show the single anal vein (vein 1) of the *Papilionidae*.

COLORATION OF BUTTERFLIES.

An account of Sudan butterflies would not be complete without some brief notes on coloration. The species described in this article include forms which illustrate excellently cryptic and warning coloration, mimicry, and sexual and seasonal dimorphism.

Cryptic & Warning Coloration.

Animals in general may be divided into those which are cryptically coloured, so that, at least when at rest, they are concealed from their enemies, and those which advertise their presence by brilliant or contrasting colours. Many examples of the former can be found amongst butterflies of the family *Satyridae*, which, when at rest, blend with the backgrounds which they select, and even an experienced observer may have difficulty in spotting them. A classical example of the latter is a wasp. The black and yellow warning colour of a wasp is readily recognised by predatory animals, who soon learn to associate it with a sting. Insects with cryptic coloration usually have habits suited to their disguise. There would, for example, be no point in an insect looking like a dead leaf, if it got up and flew away as soon as an enemy approached.

The majority of insects with warning colours are unpleasant to the taste, and are therefore left severely alone by insectivorous animals. They are bold in their habits, knowing that there is very little risk of their being attacked. Some insects with warning colours are, however, edible. They have frequently developed warning colours, because such colours have caused them to be mistaken for other insects, which are best left alone by predators. Such edible insects are usually described as mimics, although the choice of the word is unfortunate, since mimicry in its usual sense implies a voluntary effort to copy.

Mimicry.

As a general rule an insectivorous animal can only discover by experience that a certain combination of colours goes with inedibility, and it therefore follows that the model is usually a common species. It is obvious, too, that it is to the advantage of a group of inedible species to have the same combination of colours, since their enemies learn all the more rapidly to leave them alone. There are in consequence two forms of mimicry, Batesian mimicry, in which the mimic is edible and harmless, and Mullerian mimicry, in which the mimic is distasteful.

The species illustrated on plate 2 are forms of the commonly inedible species *Danaus chrysippus*, with a Batesian mimic, the female forms of *Hypolimnas misippus* ; and a Mullerian mimic, *Acraea encedon*. The typical form *Danaus chrysippus chrysippus* has as mimic the typical female form of *Hypolimnas misippus* and the form *Acrea encedon encedon*, It wil be seen from the plate that the beautiful male *Hypolimnas misippus* is a most conspicuous insect, but when it is settled on charred patches of grass, or similar places, the coloration of the underside is definitely concealing.

One of the finest examples of mimicry occurs in the females of the swallowtail butterfly, *Papilio dardanaus*, which occurs in Equatoria. The male is a typical swallowtail, but the majority of the females have no tails. Many forms of females are known, each a mimic of an unpalatable species of the family *Danaidae*. Another good example of mimicry appears in plates 3 and 5 where the rather rare *Papilio leonidas*, and the more common *Danaus petiverana* are shown.

Sexual Dimorphism.

When an insect occurs in two more or less dissimilar forms the phenomenon is called "dimorphism." Several butterflies in which the sexes are quite different have already been mentioned, and others can be detected from an examination of the plates.

Seasonal Dimorphism.

Probably the best known example of seasonal dimorphism is the butterfly *Precis octavia*, which occurs on the Nuba Mountains and Jebel Marra. The dry season form *Precis octavia amestris* is a blue insect, with a row of red spots near the outer edge of each wing, and other black markings. The wet-season form, however, is brick red with black markings. Intermediate forms occur, as for example, that illustrated in plate 5. The dry-season form is often a larger and more soberly coloured insect than the west-season form, the greater size of the dry-season form being due, in all probability, to the fact that it develops from a larva which feeds during the wet-season, when food is more plentiful. Less marked instances of seasonal dimorphism are common among the family *Pieridae*.

OCCURRENCE.

The early rains see the appearance of enormous numbers of butterflies

and this state continues throughout the rains ; then the numbers fall off until the end of the dry season, when very few butterflies are to be seen. However, an examination of wells, pools, and patches of moist earth or dung during the dry season, will usually yield specimens of most species as they come to drink. Other species, such as Lycaenids, can be found round trees bearing blossom. June and July are about the best months for collecting, though travel may not be easy in some areas at this time. Areas of vegetation different from the normal vegetation of a district will usually yield different species of butterflies, and hills also yield fresh species, usually those that would only be found much further southwards on the surrounding plains.

CLASSIFICATION.

It is unusual in an article of this type to deal with classification from the scientific viewpoint. Owing, however, to the existence of mimicry amongst our local species, some notes on classification are really essential if the reader is to be able to satisfy himself on the identity of the mimetic forms. Reference to plate 2 will show the very close similarity in general appearance between *Danaus chrysippus dorippus* and *Hypolimnas misippus inaria*. These two butterflies belong to the different families, *Danaidae* and *Nymphalidae* ; from the wing diagrams on plate 1 it will be seen that the discoidal cells of the wings in the *Danaidae* are closed, whereas those of the *Nymphalidae* are open. With this knowledge one is able to decide quite easily which species is under examination.

Butterflies are insects belonging to the order LEPIDOPTERA. The order is so called because the wings are covered with minute scales. If the insects are carelessly handled, these scales are easily detached, when they appear as a fine dust on the fingers ; and it is they which are responsible for the marvellous colours on the wings. The LEPIDOPTERA are divided into a number of families, one group of which is usually referred to as " butterflies," the remainder of them being " moths." The groups are, however, not natural ones, and hence the differences between butterflies and moths are not clearly defined. The following characters will usually enable one to decide if an insect is a butterfly or a moth :—

Butterflies fly by day ; antennae (feelers) clubbed at the tip ; when at rest wings held vertically with the upper surfaces touching over the back. The " Skippers " have the antennal clubs tapering gradually at each end, and some of them rest with the wings flat to show the upper surface.

As to moths, the majority fly by night ; antennae usually threadlike or feathered ; rest with wings folded horizontally over the back so that the upper surface of the forewings is exposed. A few bright-coloured moths fly by day, and of these some, *e.g.*, the " Burnets," have antennal clubs resembling those of the " Skippers." Some of the geometer moths rest with wings erect.

In the Sudan there are ten families, the members of which are usually called butterflies. The main characters of the families are as follows :—

(The first four families are treated by some authors as sub-families of the family, *Nymphalidae*. They agree in having the front legs of both sexes reduced, and useless for walking (plate 1 fig. 1). The chrysalis hangs by the tail).

Family *Danaidae*.

Cells of both wings closed, anal nervures of forewings forked at the base. Male with unjointed, female with jointed fore-tarsi ; no claws on forelegs of either sex. Larvae smooth, with fleshy protuberances.

Family *Acraeidae*.

Narrow-winged butterflies, usually predominantly brown, or reddish brown ; cells of both wings closed. Inner edge of hindwings without groove to enclose abdomen. Larvae with long branching hairs.

Family *Nymphalidae*.

Cells of wings open, or rarely closed by a very fine transverse vein, inner edge of hindwing with a groove to enclose abdomen. Larvae spiny or smooth.

Family *Satyridae*.

Cells of both wings closed, subcostal nervure thickened near base. Fore-tarsi of male unjointed and long-haired ; of female with short joints and less hairy. Palpi flattened, with long bristly hairs. Larvae with forked tail-segment, smooth or clothed with short hairs.

Family *Riodinidae*.

A small family, most of the members of which are found in tropical South America. The forelegs of the males are reduced and useless for walking, but in the female all six legs are perfect, although the front pair may be rather smaller than the others. The wing neuration resembles that of the *Lycaenidae*. There are no species described in this article.

Family *Libytheidae*.

Another small family of which no representative is included in this article. The family is characterised by having palpi almost four times as long as the head, and projecting forwards like a snout.

Family *Papilionidae*.

All legs well-developed in both sexes, claws large but not toothed. Inner margin of hindwing concave, and distinguished from all other families by having only one anal nervure, which is parallel to the edge of the wing ; wings often tailed. Larvae cylindrical, never hairy ; but sometimes with fleshy knobs, and a retractile horn behind the head. Pupae standing on the tail, and held up by a silken girdle ; two frontal tubercles.

Family *Pieridae*.

All legs well-developed in both sexes, claws bifid toothed, venation similar to that of *Papilionidae* ; but two anal nervures present in hindwings. Larvae cylindrical and hairy ; pupae as in *Papilionidae*, but only one central frontal tubercle.

Family *Lycaenidae*.

Forelegs almost as large as the other two pairs, forefeet in the male usually unjointed, and terminating in a simple hook, in the female jointed, and having two claws ; neuration as in the *Hesperidae* ; but only three or four radial nervures present, antennae inserted close together. Larvae strongly convex above, and flat below ; short and hairy. Pupae standing on the tail, and held up by a silken girdle.

Family *Hesperidae*.

All six legs well-developed, claws short. Forewings with five equally-spaced radial veins. Head broad, antennae widely separated at the base, and eyes prominent ; body relatively stout for size, larvae with a large head, and narrow thoracic segments. Pupae in a slight silken cocoon.

The important distinguishing features are illustrated in Plate 1, and it is hoped that with the help of these figures the reader will have no difficulty in deciding to which family a butterfly belongs, whether it is described in this article or not.

DESCRIPTION OF SPECIES

Family *DANAIDAE*.

Genus Danaus Klug.

Danaus chrysippus Linn. (Plate 2)

General colour browny orange, with black margins to the wings, and white and black spots. Four different forms occur. The typical form *Danaus chrysippus chrysippus* Linn. has the whole of the apical portion of the forewing black, with a series of white spots forming a bar across the tip. The form *D. chrysippus dorippus* Klug. has only the margin black and is without the white bar of the typical form. A form similar to *dorippus* but with a white centre to the hindwing is sometimes encountered. This is *D. chrysippus albinus* Lanz. The fourth form is *D. chrysippus alcippus* Cr. This is similar to the typical form, but like *albinus* has white centres to the hindwings. The sexes are similar, except that the males have four black spots on the hindwings, instead of three as in the female. The extra spot is a sex pouch, which is a small pocket in the centre of the wing which may have olfactory properties.

This is one of the commonest butterflies in the country. The most plentiful forms are *chrysippus* and *alcippus*, though *dorippus* is not uncommon; *albinus* is rare. It is on the wing throughout the year, and the distinctive barred larvae are frequently to be found feeding on the leaves of the " Dead Sea Apple " or *Usher* (*Calotropis procera* Ait).

Danaus petiverana Doubl. & Hew. (Plate 3)

This species has a blackish ground colour, and light blue-green markings ; the forewing has a longitudinal streak at the base of the cell, and the hindwing, deeply cleft basal marks. The cell of the forewing has a transverse spot beyond the middle. Both wings have discal spots, and small submarginal spots. The ground colour of the undersurface is lighter, more greyish than the upper, and distinctly brownish over the basal two-thirds of the forewing and at the base of the hindwing. The sexes are alike in colour, the female being slightly larger.

It occurs fairly widely throughout the country, but is usually only rarely seen, though during the rains it may be very common in the Nuba Mountains, on Jebel Marra and in other places. The flight is slow and weak. It is the model for the mimic swallowtail *Papilio leonidas*.

Family *ACRAEIDAE*

An interesting characteristic of this family is their high resistance to

cyanide poisoning. If an ordinary cyanide killing bottle is used in collecting this species, it is advisable to nip the thorax of the specimen before putting it in ; otherwise it may fly around in the bottle for nearly an hour.

Genus Acraea Fab.

Acraea encedon Linn. (Plate 2)

This is a very variable species, and is a very good example of a Mullerian mimic, as it has forms imitating the forms of *Danaus chrysippus*. The general ground colour is yellow brown, and there are brownish black and white markings corresponding to those of the forms of *D. chrysippus*. *A. encedon encedon* Linn, is a mimic of *D. chrysippus chrysippus* : *A. encedon daira* G. & S. is a mimic of form *dorippus* : *A. encedon alcippina* Auriv. is a mimic of form *alcippus*. This is a widely-spread species, usually found flying singly in open grassland. The typical form is usually seen, but a form where the brown background is replaced by white is not uncommon. At Kurmuk in January all forms have been seen in fair numbers flying together.

Acraea terpischore Linn. (Plate 3)

This species has a brownish-orange ground colour, with brownish black markings. The markings are variable, especially in the females ; but confusion should not occur in the central Sudan, as there is no common species resembling it.

It is extremely common in many moist low-lying places in the Nuba Mountains, though rarely to be met with elsewhere. It is not a strong flyer, and keeps close to cover.

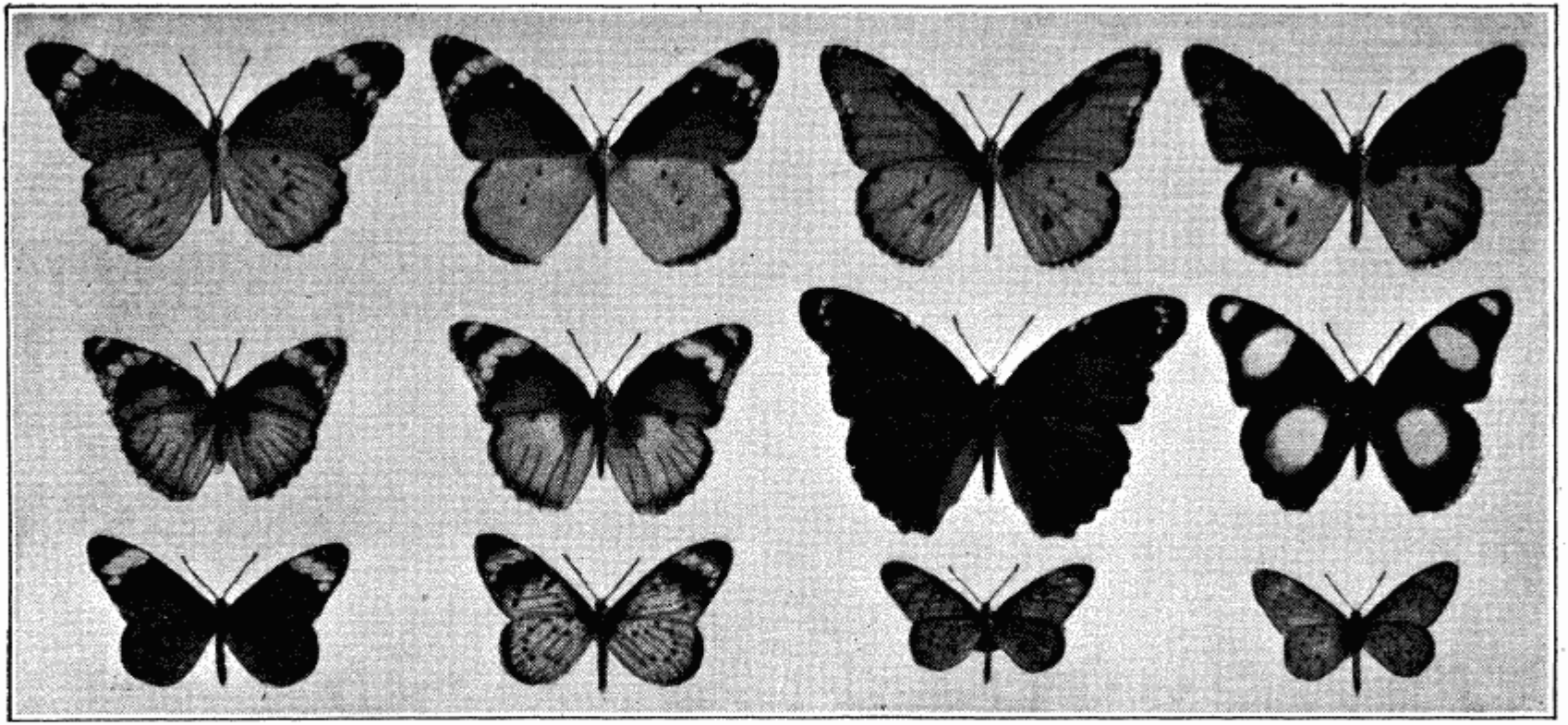
Acraea neobule Doubl. (Plate 3)

This species has a pinkish red colour, with slight transparency in the forewings. The female is larger than the male, and may have the pink colour replaced with dull ochreous, to white or buff. It is easily distinguished from the foregoing species, but might possibly be confused with the next species ; it is found in small numbers, usually singly, throughout the central Sudan. It seems to prefer to fly round the highest objects in the vicinity, and may often be seen flying round the tops of trees.

Acraea caecilia Fabr. (Plate 3)

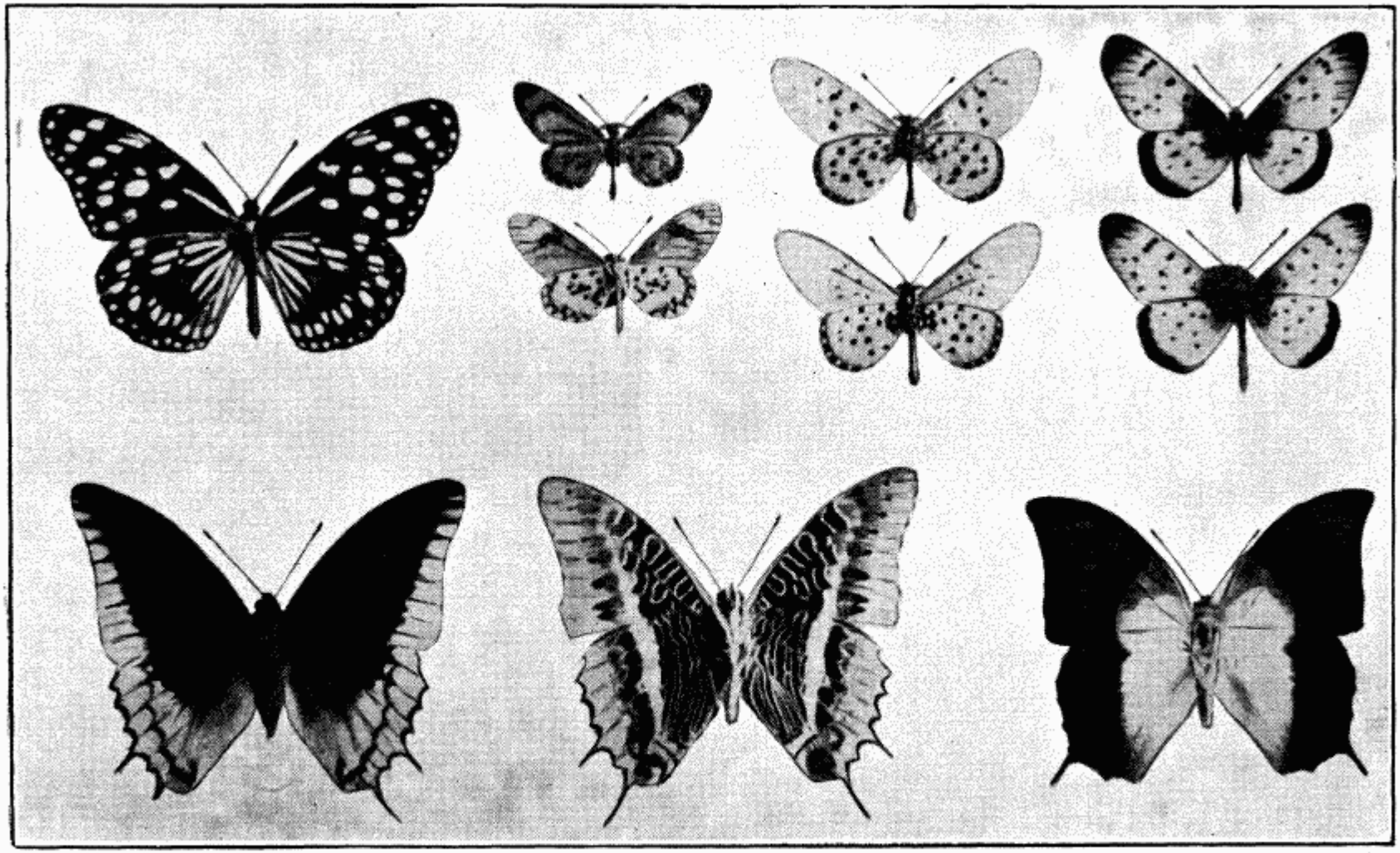
This species is distinguished from the foregoing species by its opaque

PLATE 2.



Danaus chrysippus chrysippus M.	Danaus chrysippus alcippus F.	Danaus chrysippus dorippus M.	Danaus chrysippus albinus M.
Hypolimnas misippus F. Form misippus	Hypolimnas misippus F. Form alcippoides	Hypolimnas misippus F. Form inaria	Hypolimnas misippus M.
Acraea encedon encedon	Acraea encedon	Acraea encedon daira	Acraea encedon daira (underside)

PLATE 3.



Danaus petiverana

Acraea terpischore
Acraea terpischore (underside)

Acraea neobule
Acraea neobule (underside)

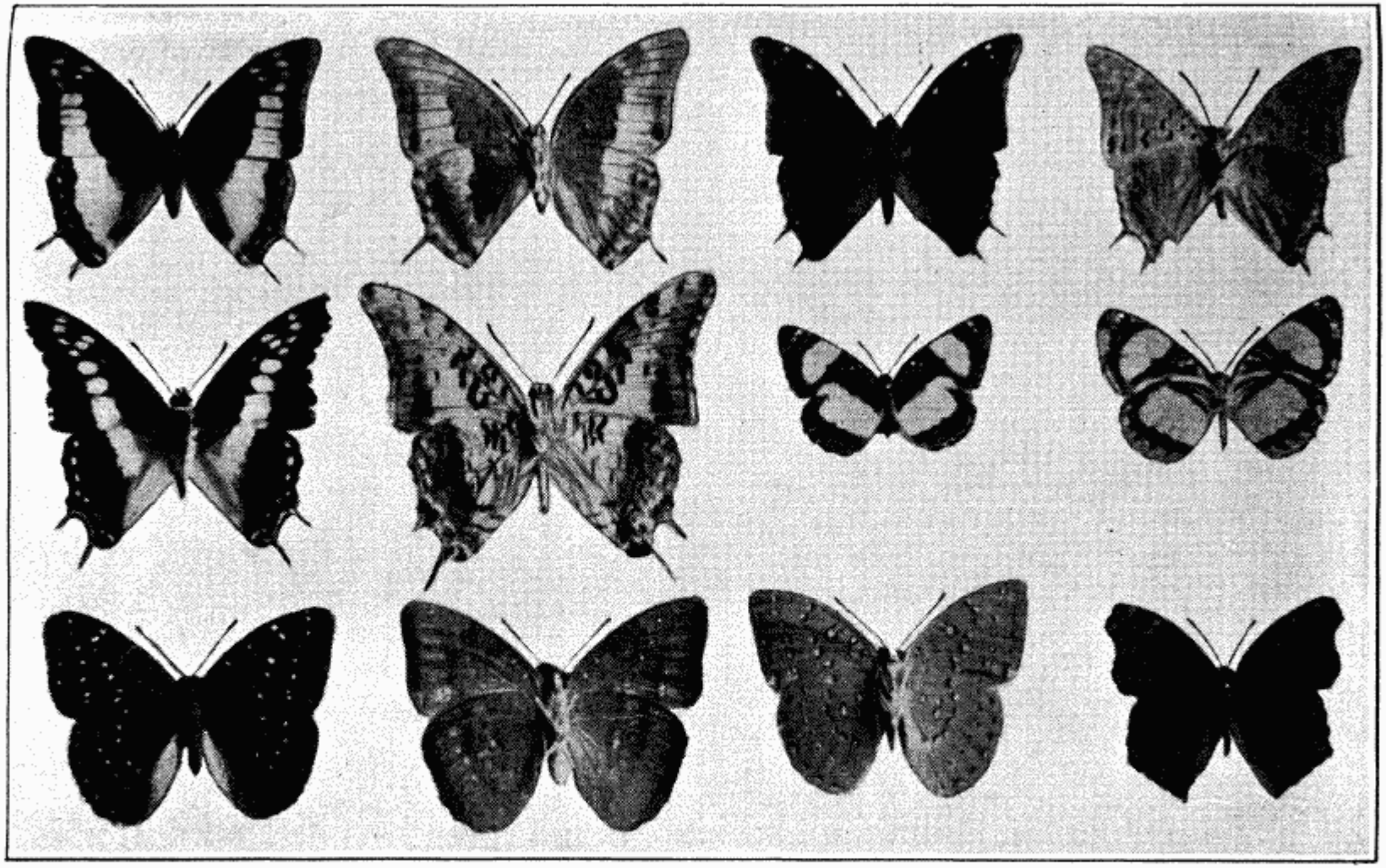
Acraea caecilia F.
Acraea caecilia M.

Charaxes jasius epijasius

Charaxes jasius epijasius (underside)

Charaxes varanes

PLATE 4.



Charaxes etheocles F.

Charaxes achaemenes

Hamanumida daedalus

Charaxes etheocles F. (underside)

Charaxes achaemenes (underside)

Hamanumida daedalus (dry season form underside)

Charaxes etheocles M.

Neptis agatha

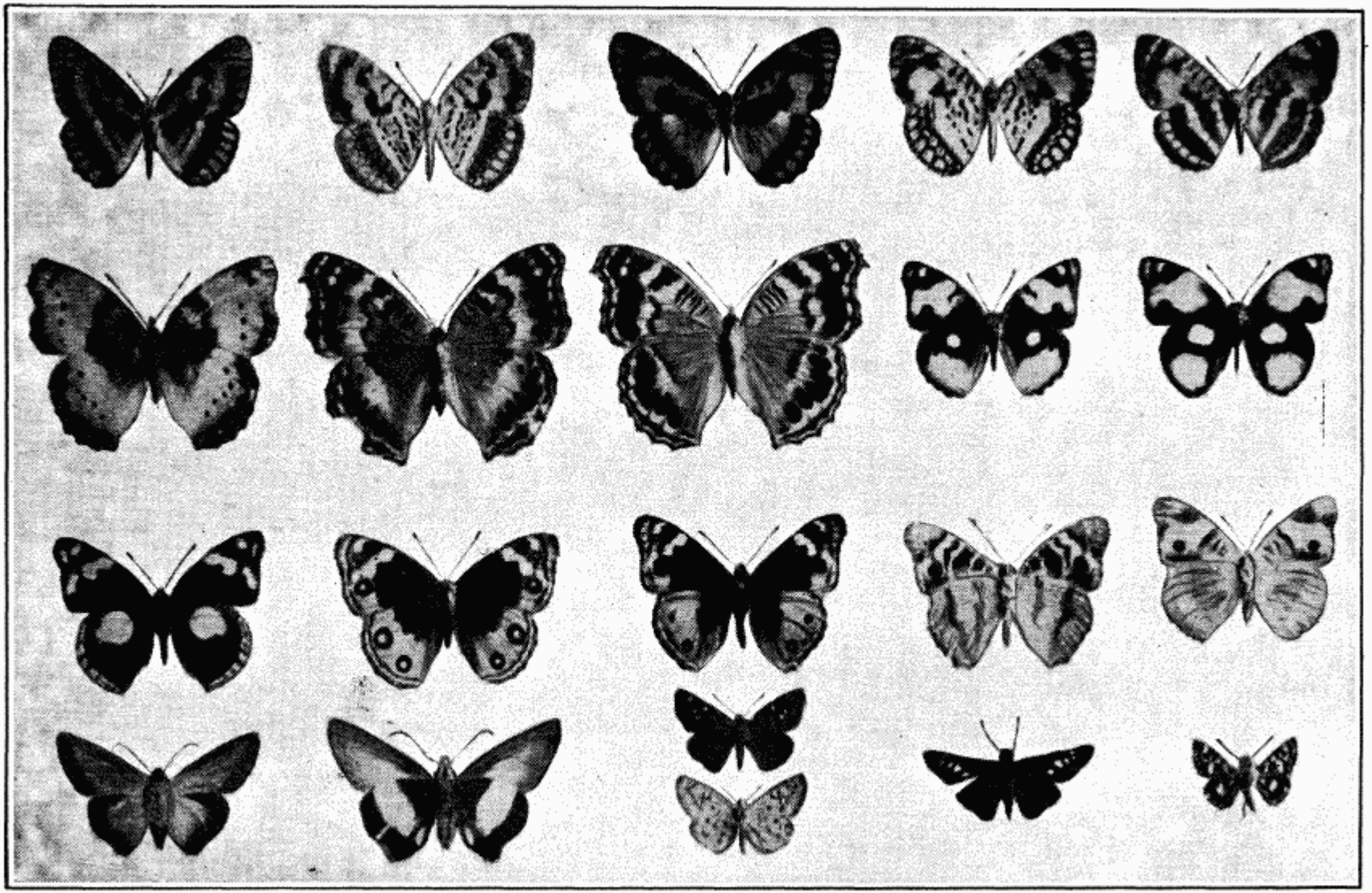
Hamanumida daedalus (wet season form underside)

Charaxes etheocles M. (underside)

Neptis agatha (underside)

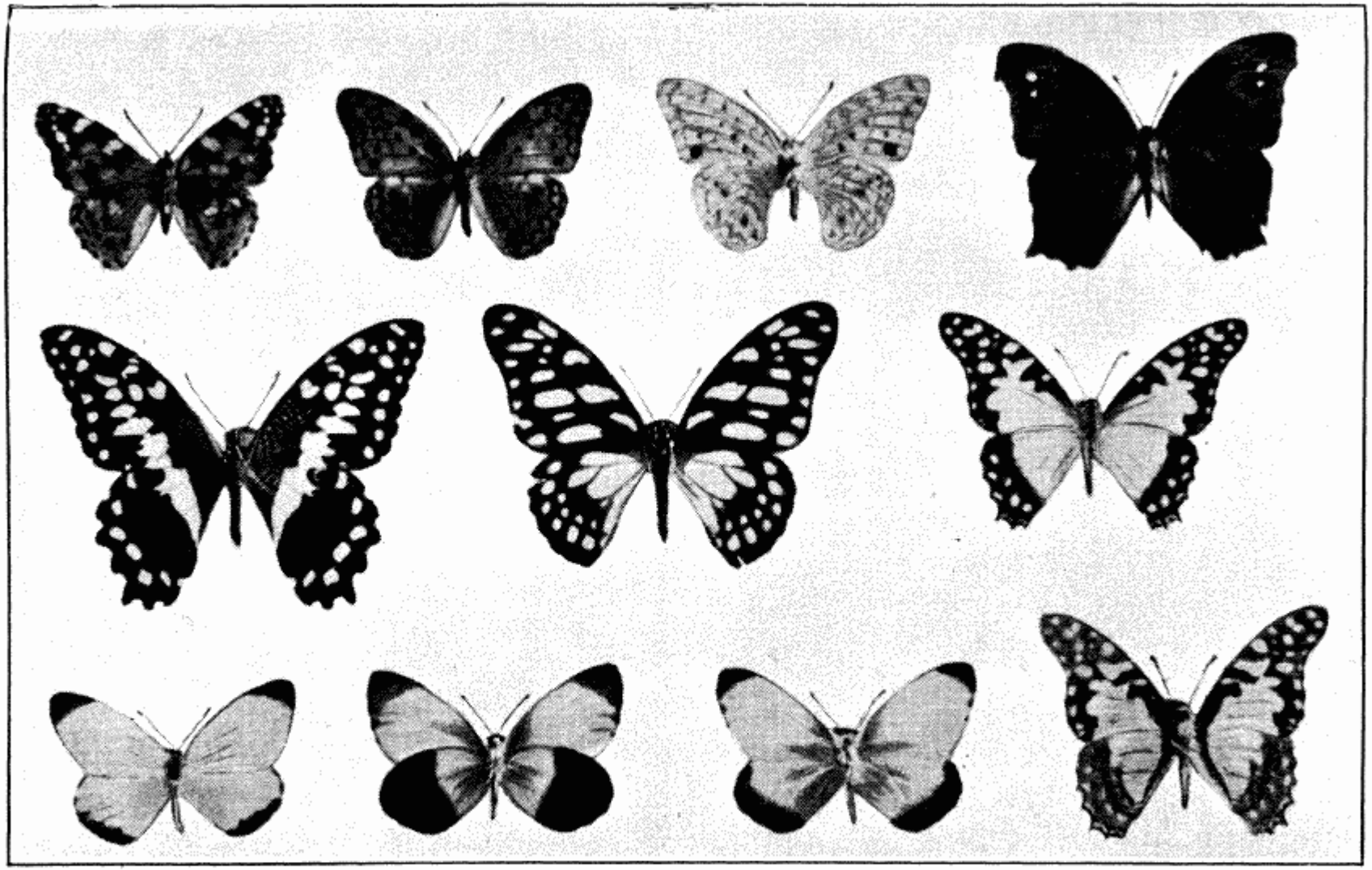
Precis chorimene

PLATE 5.



Byblia ilythia	Byblia ilythia (underside)	Byblia acheloia	Byblia acheloia vulgaris (wet season underside)	Byblia acheloia (dry season underside)
Precis octavia octavia	Precis octavia (intermediate form)	Precis octavia amestris	Precis hierta F.	Precis hierta M.

PLATE 6.

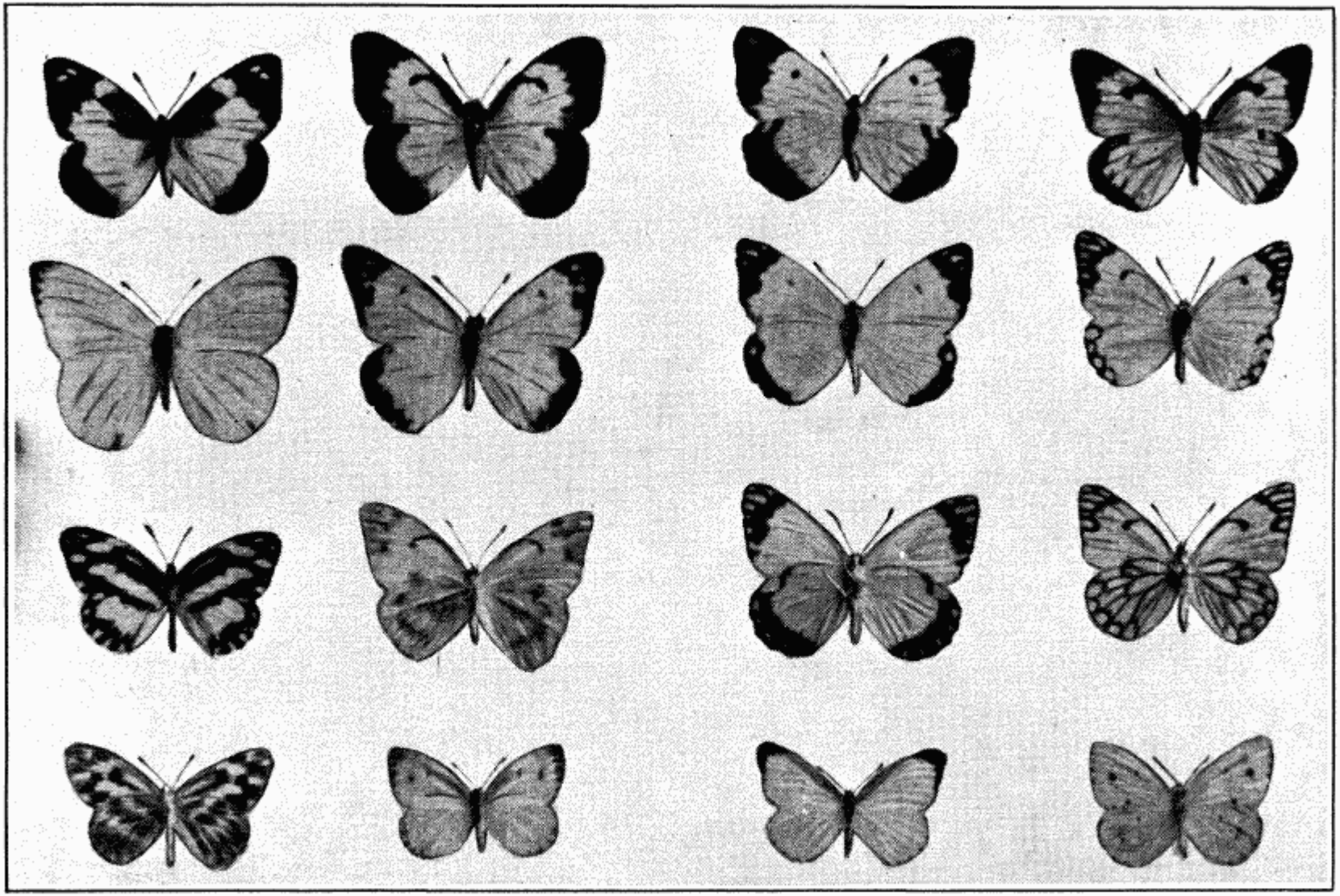


Vanessa cardui — Phalanta phalantha — Phalanta phalantha — Melanitis leda

Papilio demodocus — Papilio leonidas — Papilio pylades

Mylothris chloris M. — Mylothris chloris F. (underside) — Mylothris chloris M. (underside) — Papilio pylades (underside)

PLATE 7.



Appias epaphia F.
Appias epaphia M.
Pinacopteryx eriphia

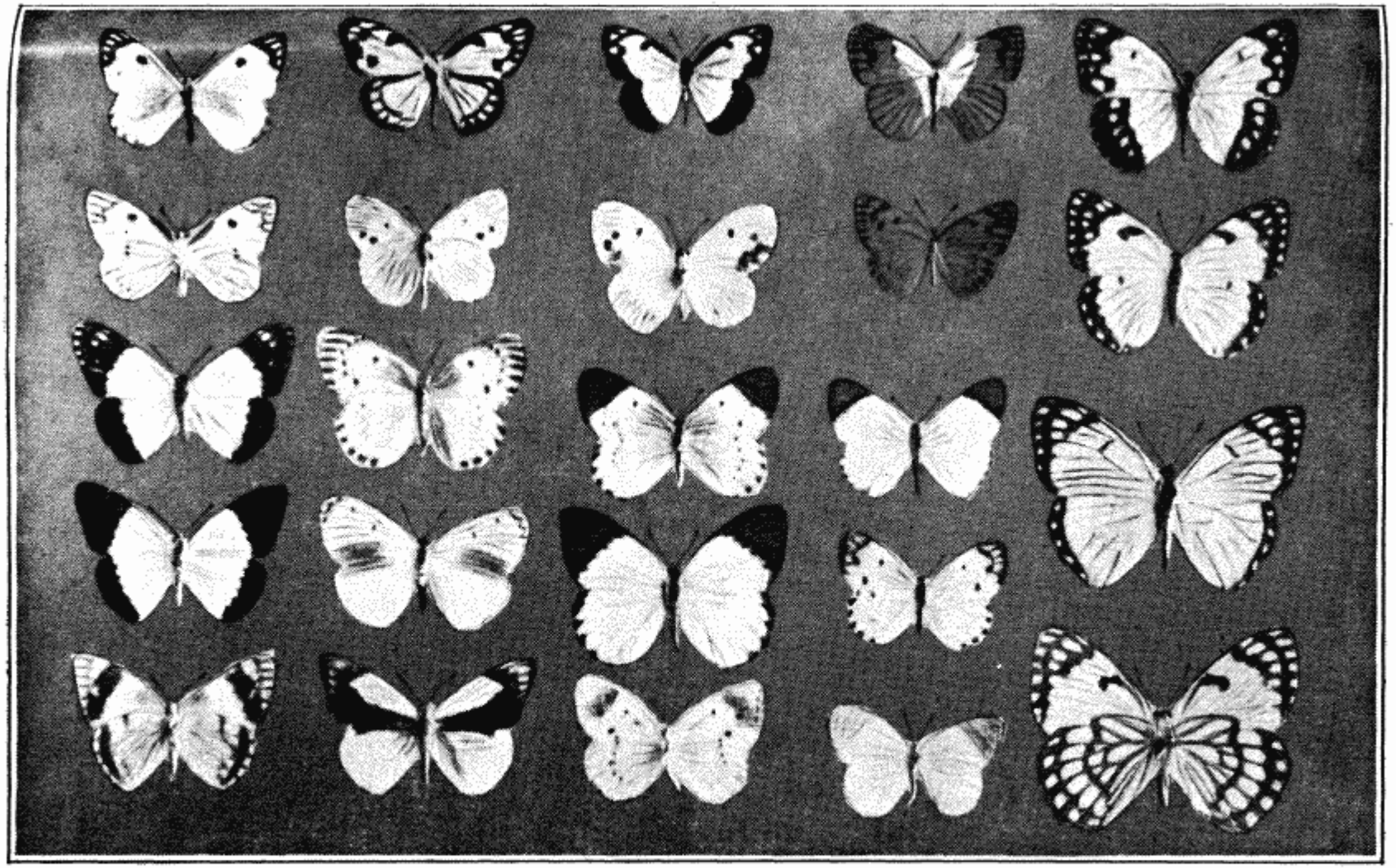
Pinacopteryx eriphia

Anaphaeis gidica F.
Anaphaeis gidica M.
Anaphaeis gidica M. (underside)
Dixeia doxo F.

Anaphaeis creona F.
Anaphaeis creona M.
Anaphaeis creona M. (underside)
Dixeia doxo M.

Anaphaeis mesentina F.
Anaphaeis mesentina M.
Anaphaeis mesentina M. (underside)
Dixeia doxo M.

PLATE 8.



Colotis eulimene
Colotis eulimene (underside)
Colotis celimene F.
Colotis celimene M.
Colotis celimene M. (underside)

Colotis amatus
Colotis amatus (underside)
Colotis halimede F.
Colotis halimede M.
Colotis eris M.

Colotis phisadia
Colotis phisadia (underside)
Colotis danae F.
Colotis danae M.
Colotis danae F. (underside)

Colotis chrysonome F.
Colotis chrysonome M.

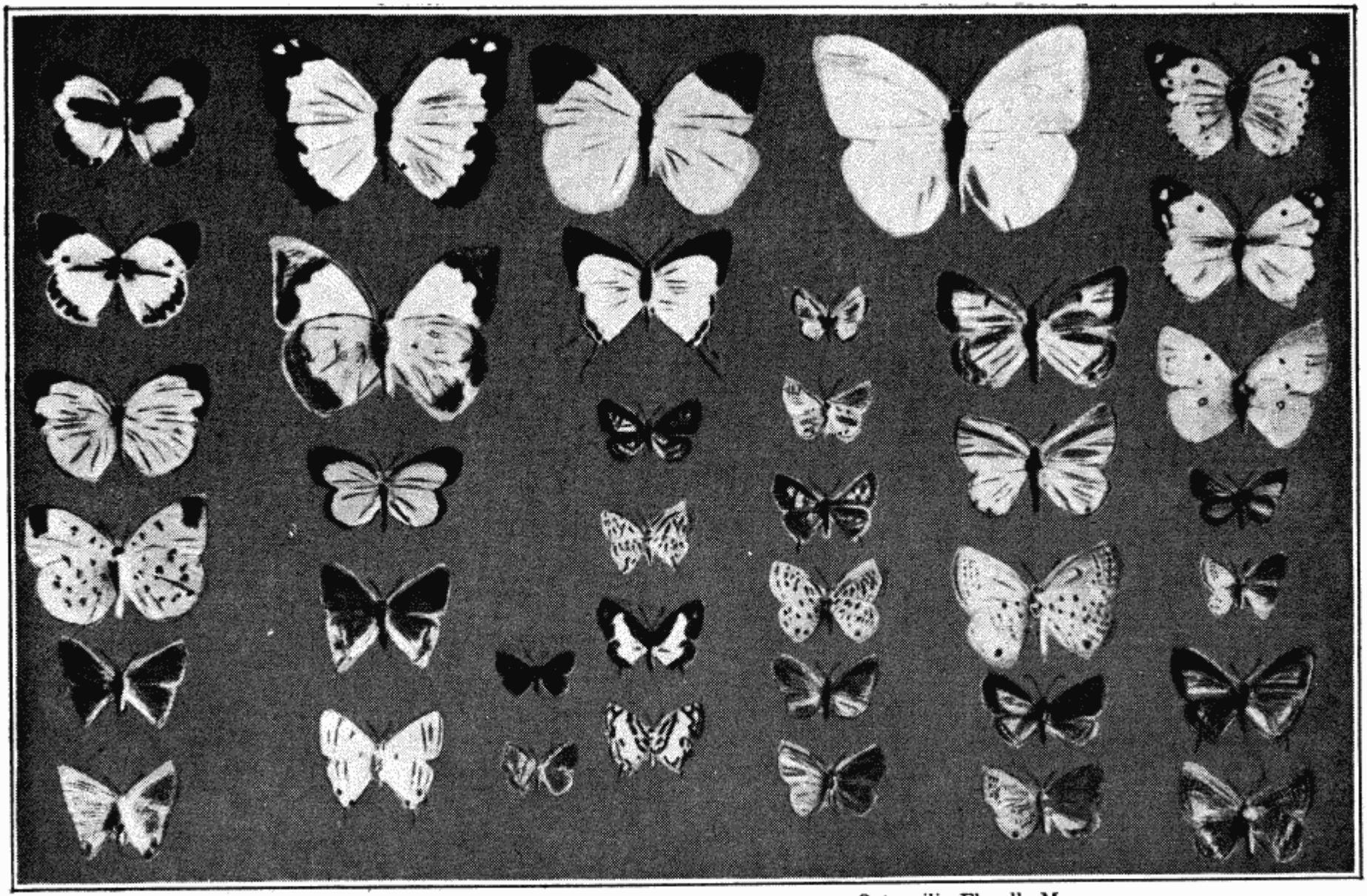
Colotis ephyia M.
Colotis evarne F.
Colotis evarne M.

Colotis vesta
Colotis protomedia F.

Colotis protomedia M.

Colotis protomedia F. (underside)

PLATE 9.



Colotis daira F.
Colotis daira M.
Euremia hecabe
Euremia hecabe (underside)
Deudorix livia
Deudorix livia (underside)

Eronia cleodora
Eronia cleodora (underside)
Euremia desjardinsi
Hypolycaena philippus
Hypolycaena philippus (underside)

Eronia leda
Argiolaus menas
Tarucus mediterraneae
Tarucus mediterraneae (underside)
Castalius cretosus
Castalius cretosus
Freyeria trochylus
Freyeria trochylus

Catopsilia Florella M.
Azanus ubaldus
Azanus ubaldus (underside)
Syntarucus telicanus F.
Syntarucus telicanus (underside)
Pseudonacaduba

Euchrysops polydialecta F.
Euchrysops polydialecta M.
Euchrysops polydialecta M. (underside)
Euchrysops malathna

Colias hyale (yellow form)
Colias hyale (yellow form)
Colias hyale (underside)
Zizeeria hylae
Zizeeria hylae

ochreous or salmon pink colour, and its black hind border. The female may resemble the male, or the ochreous colour may show partial or complete replacement by white.

It is usually found flying singly in the acacia-grass areas, fairly close to the ground, and in some areas may be found in considerable numbers, but as a general rule is not encountered so frequently as the preceding species.

Family *NYMPHALIDAE*

Sub-Family *Charaxidinae*

Genus Charaxes Oberth.

Charaxes varanes Cram. (Plate 3)

This species has the basal half of both wings white, with a suspicion of a bluish tinge. The outer half is orange, with the darker portions orange-brown and with orange spots. The sexes are similar.

It occurs commonly in the Nuba Mountains, and other areas in the central Sudan as far east as Kassala, and possibly on the Red Sea hills, occurring often on hills among trees; it flies less rapidly than the other species of *Charaxes*. On the wing it is easily seen, but when at rest it is difficult to detect.

It may often be met with feeding on trees bearing blossom, or exuding sweet substances. In the Nuba Mountains in November, a single Camel Foot tree (Bohinnia sp.), which had a sticky secretion on its pods, yielded several examples of three species of Charaxes, as well as other species, in a very short time.

Charaxes jasius epijasius Reiche. (Plate 3)

This species is mainly blackish-brown, with an ochreous border on the forewing and hindwing, and with the centre of the hindwing coloured blue. The underside is highly ornate, mainly with reddish chestnut markings, but with diagonal white stripes extending across both wings, and an ochreous border. It is a widespread and fairly common species, though it is an extrememly rapid flyer, and is not easy to catch; it is usually seen flying rapidly, but may occasionally be found drinking on patches of damp sand. It is usually found in the vicinity of grasses of the millet family, on which the larvae feed.

Charaxes achaemenes Fldr. (Plate 4)

This species is coloured grey-black above, with a marked white

stripe on each side, extending across both wings. The underside is mainly grey. It is a fairly widespread species in the central Sudan, frequenting trees at the foot of hills, and can often be caught when drinking on damp earth. The males may also often be found settled on a prominent branch, periodically making a rapid flight round the area of the bush, and returning to the chosen branch. It is the easiest to catch of the *Charaxes* species.

Charaxes etheocles. (Plate 4)

This species is a member of a group of *Charaxes*, the scientific position of which is still in a state of extreme confusion; but the examples seen in the central Sudan appear constant in colour, and distinctive, and so can be regarded for practical purposes as one species. This is the smallest species of *Charaxes* usually encountered, and is an extremely rapid flyer. The males are blue-black on top, and the females are brownish black, with a pale area on the hindwing yellowish, changing outwards to pale blue. The underside of both sexes is mostly grey. These butterflies are usually seen flying at speed in the vicinity of pools, and sometimes settle for short periods; they are very difficult to catch, but may sometimes be found feeding on blossom, or sweet exudations from trees.

Sub-Family *Nymphalinae*.

Genus Hamanumida Hubn.

Hamanumida daedalus Fabr. (Plate 4)

This species is the only member of the genus, and differs from other species of Nymphalids in that it can occur in fairly open districts, whereas they are confined to wooded districts. The upper surface is coloured brownish-grey with white spots, and the under side varies from dark brown in the dry season, to orange with light spots in the rains. It is widespread in the central Sudan, occurring in places near surface water sometimes in large numbers, and may often be disturbed from patches of shadow cast by trees. It is a rapid flyer, but may be caught when it settles in patches of shade.

Sub-Family *Neptidinae*

Genus Neptis Fabr.

Neptis agatha Stoll. (Plate 4)

This species is coloured black and white, though sometimes the black is tinged with brown. It is widespread throughout the central

Sudan, occurring in small numbers. It has a distinctive flight consisting of rapid flaps, followed by glides with the wings held slightly below horizontal; it is usually found in wooded places, though it may appear in open country.

Sub-Family *Eurytelinae*

Genus Byblia Hubn.

Byblia ilithyia Drury. (Plate 5)

This species is coloured brown and black above, and black and ochre below, with two distinctive cream bands on the hindwings; unlike the next species, it does not have distinctive wet and dry season forms. It is a very common species on grassy plains, but in thinly wooded areas is replaced by the next species.

Byblia acheloia Wallengr. (Plate 5)

This species is coloured above similarly to the preceding species, but the dry season form has the underside of the hindwing strongly marked with chocolate, instead of ochre, and the rainy season form (*Byblia vulgaris* Stgr.) is coloured similarly to *Byblia ilithyia* underneath, but lacks the cream bands on the hindwings. It is less common than the preceding species, and is found in more wooded districts. The dry season form is very distinctive on the wing, but the wet season form may be confused.

Genus Hypolimnas Hubn.

Hypolimnas misippus Linn. (Plate 2)

This species is an extremely good example of sexual dimorphism. The male is coloured black above, with white spots surrounded by a purple sheen. The females are quite dissimilar, being mainly brown with black markings, and are Batesian mimics of the different forms of *Danaus chrysippus*. The under surfaces, however, do bear some resemblance to each other. The type form *Hypolimnas misippus* female form *misippus* resembles the type form *Danaus chrysippus chrysippus*; *H. misippus inaria* resembles *D. chrysippus dorippus*; *H. misippus alcippoides* resembles *D. chrysippus alcippus*; and *H. misippus dorippoides* resembles *D. chrysippus albinus*.

This is an extremely common butterfly, and the first three female forms can be found nearly everywhere. The larvae are also common in the early rains on *Rigla* (*Portulacca sp.*), and are coloured black covered with short spines.

The main distinguishing feature between the two species is the closed cell on the forewing of *D. chrysippus*, and the open cell, characteristic of the *Nymphalidae*, in the forewing of *H. misippus*.

Genus Precis Hubn.

Precis chorimene Guer. (Plate 4)

This species is mainly dark yellowish brown above, and usually slightly greyer underneath. It is quite widely distributed in the central Sudan, but is usually only found rarely and singly, at least in the dry season; it seems to prefer the shelter of undergrowth, in the more wooded parts in the vicinity of hills.

Precis octavia Cram. (Plate 5)

This species is a very fine example of seasonal dimorphism, the rainy and dry season forms differing exceptionally from each other. The dry season form *P. octavia amestris* Drury. is mainly blue on the upper side, with black markings, and a band of brick red spots parallel to the outer margin, and dark brown below. The rainy season form *P. octavia* Cram. is mainly pinkish red with black markings above, and below; a small number of intermediate forms can also be found at the end of the rains, mixed with the other two forms. The dry season form is considerably larger than the rainy season form, because it is hatched from larvae which have fed during the rains, when food is more plentiful.

This species occurs in fairly open country on the base of hills in the Nuba Mountains, and on the lower parts of Jebel Marra, and in some places can be extremely plentiful.

Precis hierta Fabr. (Plate 5)

This species is mainly yellow above, with black markings, and a large blue spot at the front of the hindwing; it is widely distributed, and a very common species, occurring on open ground from the summit of Jebel Marra at 10,000 ft. throughout the central Sudan. It appears in Seitz's "*Macrolepidoptera of the world*" Vol. 13 as *Precis cebrene* Trim.

Precis clelia Cram. (Plate 5)

This species is mainly black above with white markings, and a blue patch on the hindwing similar to the preceding species. It is not very common, but is widespread in occurrence, occurring with the preceding species.

Precis orythia Linn. (Plate 5)

This species is mainly black on the forewing above, and blue on the hindwing, with marked eye spots, which are more plentiful in the females. It has a similar range to the preceding species, but is more common.

Genus Vanessa Fabr.

Vanessa cardui Linn. (Plate 6)

This species is pinkish orange with dark brown markings above. It is remarkable for its nearly world-wide distribution, occurring in America, Europe, Asia, and Africa, from the Arctic Circle to the Equator, and south ; and up to at least 10,000 ft., as it also occurs on the summit of Jebel Marra. The other remarkable thing is that throughout all this range the species shows almost identical colouring and markings. It is found throughout the Sudan fairly commonly.

Genus Phalanta Horsfield.

Phalanta phalantha Drury. (Plate 6)

This species is coloured yellowish brown above with black markings. It is not a common species, but appears to be not infrequent in the early rains in lightly wooded areas.

Family *SATYRIDAE*

Members of this family occur widely throughout the central Sudan, but usually as solitary individuals. Contrary to their habits in more northern countries, in the Sudan they are usually shade-loving, only appearing in the open towards evening. They can however often be disturbed from patches of vegetation, where they have taken shelter.

The species given is the only one to occur with any frequency.

Genus Melanitis Fabr.

Melanitis leda Linn. (Plate 6)

This species is mainly dark brown above, with an orange-red area at the apex of the forewing containing a large black spot, and two small white spots. It occurs not infrequently, and is a widespread species, but is not seen so often as it might be, owing to its habit of hiding in undergrowth during the day, and only flying in the open in the evening.

Family *PAPILIONIDAE*

Genus Papilio Linn.

Papilio demodocus Esp. (Plate 6)

This species is black with yellow markings above; underneath the dark markings are dark brown. An area on the hindwing above is greyish owing the mixture of black and yellow scales. It is a common universal species, known as the Citrus butterfly, as its larvae feed on the leaves of lime and other citrus.

Papilio pylades Fabr. (Plate 6)

This species is coloured black and white above, and similarly with additional red markings below. It is widespread throughout the central Sudan, but is rather uncommon. It may be confused with the common white butterflies, with which it mixes at drinking places, but is larger and has a much stronger flight.

Papilio leonidas Fabr. (Plate 6)

This species is coloured pale green and black above, and is a mimic of *Danaus petiverana*. It is an uncommon species, but may be seen in small numbers near trees at the beginning of the rains. In common with other *Papilionidae* it appears to be fond of feeding on blossom

Family *PIERIDAE*

Genus Mylothris Hubn.

Mylothris chloris Fabr. (Plate 6)

This species is pearly white above, with black markings, below the hindwing is reddish yellow with a wide border, wider in the female than the male. The flight is rather weak, and it usually flies under trees, out of the direct sun. It occurs very plentifully in certain places, notably in the Nuba Mountains, and near Jebel Marra, and is usually found in the close vicinity of the trees along the channels of *khors*, and in valleys on higher ground.

Genus Appias Hubn.

Appias epaphia Cram. (Plate 7)

In this species sexual dimorphism occurs, the sexes are both coloured black and white, but the female is much more heavily marked

than the male, which has only a small amount of black on the wing tips. It is a fairly common species, occurring in small numbers near flowers in the early rains; it is found in the vicinity of trees and shade. The male is distinguished from other *Pieridae* by a brush-like structure on the lower side of the abdomen at the posterior end.

Genus Anaphaeis. Hubn.

This genus contains species which occur in vast numbers, and which may give rise to some confusion in identification, owing to the considerable variation of individuals of the same species. The specimens illustrated are typical of the majority of individuals.

Anaphaeis gidica Godt. (Plate 7)

This species is coloured brownish black and white above, the female having more black than the male. It is an extremely common and widespread species in lightly wooded country, and may be found in quantities drinking on damp earth in company with the two following species. This habit is very widespread among the *Pieridae.*

Anaphaeis creona Cram. (Plate 7)

The background colour of this species varies from white to yellow, which may be quite bright on the underside. The markings are black or brownish black, and again the female is more strongly marked than the male. The habits of this species are similar to those of the preceding one, but it is more common.

Anaphaeis mesentina Cram. (Plate 7)

This species has the same coloration as *A. gidica.* It is found very commonly on damp places with the preceding two species, where it is usually the most common, and also occurs throughout open bush country.

Genus Dixeia Talbot.

Dixeia doxo venata Butl. (Plate 7)

This species is coloured white, with black markings. It is widespread in occurrence, but does not come so far north as the preceding species. It is found commonly on the White Nile, Nuba Mountains, and foothills of Jebel Marra, in open bush country.

Dixeia (*Pinacopteryx*) *eriphia* Godt. (Plate 7)

This species is coloured black and cream above, and greyish brown

and cream below. It is widespread and common in occurrence in open bush country, along with several species of *Colotis* and *Anaphaeis*.

Genus Colotis Hubn.

This genus contains a large number of species which are mainly coloured white, with red or purple tips to the forewings. They show seasonal dimorphism, in which the wet season forms usually show more black than the dry season forms and are in general more brightly coloured.

Although other species may be met with, those given below are the most common.

Colotis amatus calais Cram. (Plate 8)

This species is salmon-coloured above, with brownish black markings, and yellow below, also with black markings. It is widespread in the arid country north of the open acacia zone, though usually found only in small numbers.

Colotis phisadia Godt. (Plate 8)

This species resembles the previous species in colour and range, and is also found only in small numbers.

Colotis chrysonome Klug. (Plate 8)

This species is coloured orange yellow with black markings above, the female having a greyish white area on the inner part of the wing. It is a widespread and locally common species in the same area as the preceding species.

Colotis vesta Reiche. (Plate 8)

This species is coloured white above, with a black border containing yellow spots. Its zone overlaps, and extends more to the south than that of the preceding species; it is found in small numbers in the thorn bush country.

Colotis protomedia Klug. (Plate 8)

This species is coloured bright yellow with black markings, the sexes being of different pattern. It is a very common and widespread species throughout the year in the thorn bush country.

Colotis celimene Luc. (Plate 8)

This species is white above with black markings, with purplish red wing tips in the male, and black wing tips in the female. It occurs

fairly commonly in the Nuba Mountains, and westwards into Darfur. The males are easily seen, as they take up a position in the lee of the more prominent trees, and then fly backwards and forwards about ten feet from the ground ; they chase other butterflies that fly near, but return to their chosen tree. They are not easily frightened away, and so are easy to catch. The females are difficult to see, as they mix with the other species of white butterflies that are flying in the same area.

Colotis eulimene Klug.

This species is coloured white above, with black markings, and a reddish yellow patch on the extremity of the forewings. It is common in limited areas, occurring north of the open bush country in sandy areas where *tundub* (*Capparis decidua* Pax.) is the common bush. It is found flying round *tundub* bushes in company with *Colotis ephyia*.

Colotis eris Klug. (Plate 8)

This species is coloured white or yellowish above, with black markings, which turn brownish at the wing tips. It is widespread as with the preceding species, but only occurs in small numbers.

Colotis danae Klug. (Plate 8)

This species is white above, with bright red black bordered wing tips in the male ; the female having more black, with wing tips grading from red to nearly black. It is widespread, and probably the commonest species of *Colotis* over large areas.

Colotis daira Klug. (Plate 9)

This species is white above, with red tips and black markings in the male, and yellow above with brownish black markings in the female. It is common at the north of the lightly forested country, and usually flies very close to the ground.

Colotis ephyia Klug. (Plate 8)

This species is white above with pinkish red wing tips and slight black markings ; the sexes are nearly alike. It is common in limited areas, occurring with *Colotis eulimene* in the vicinity of *tundub* bushes.

Colotis evarne Klug. (Plate 8)

This species is yellow above, with reddish orange tips, and slight black markings in the male, and yellowish white above with black markings and reddish orange wing tips in the female. It is widespread,

and sometimes very common over the same range as *C. danae*, and is fond of the flowers of various bushes. The male bears some resemblance to *Eronia leda* though it is much smaller.

Genus Eronia Bsdv.

Eronia cleodora Hubn. (Plate 9)

This species is white with black markings above; beneath it is white brown markings on the forewing, and yellow with brown markings on the hindwing. It is a widespread species in the central Sudan, being found in small numbers amongst low bushes. It is easily confused with other white butterflies.

Eronia leda Bsdv. (Plate 9)

This species is bright yellow above with orange tips with a thin black border. The sexes are slightly dissimilar. It is common in places in the southern Fung, the Nuba Mountains, and southern Darfur, and is usually found in fairly thick forest.

Genus Catopsilia Hubn.

Catopsilia florella Fabr. (Plate 9)

This species is pale yellowish green, almost white, in both sexes, but there is another common form of the female, which is pale orange yellow. It is one of the commonest species in the central Sudan in open country, and both forms of female occur together.

The larva can be found commonly feeding on the leaves of the *Senna* plant (*Cassia sp*), and is green, with a yellow band on each side.

Genus Euremia Moore. (*Terias* Swains)

This is a small genus, easily distinguished from any other, of small weak-flying butterflies. They do however show considerable variation, and identification may not be easy. The two species illustrated are those usually encountered, and should be fairly easily identified.

Euremia hecabe Linn. (Plate 9)

This species is bright yellow above, with brownish black wing tips. It is common and widespread, and may be found in enormous numbers drinking at patches of damp earth at the end of the rains.

Euremia desjardinsi Bsdv. (Plate 9)

This species is coloured as the preceding species, and occurs together with it, though in much smaller numbers.

Genus Colias Fabr.

Colias hyale marnoana Rog. (Plate 9)

This species is either white or yellow above, with a black border. It is found very commonly in irrigated areas on *berseem*, (*Medicago sativa*) which is the food plant of the larva. It does not appear to occur outside these areas.

Family *LYCAENIDAE*.

Genus Deudorix Mew.

Deudorix livia Klug. (Plate 9)

This species is coloured greyish blue above, with a brownish border in the female, and orange red with a brown border to the forewing in the male. It is a widespread species in thorn scrub country, where it may most often be caught at flowering trees. The larva is flesh-coloured and occurs on *Sunt* (*Acacia arabica*) trees.

Genus Hypolycaena Fldr.

Hypolycaena philippus Fabr. (Plate 9)

This species is dark grey blue above, and pale grey below. It is widespread in thorn bush country, and can be very common in some areas, such as the borders of *Sunt* forests.

Genus Argiolaus Drc.

Argiolaus menas Ham. Drc. (Plate 9)

This species is white above, with a bluish tinge and black border; it is very striking, and may be found commonly in the Nuba Mountains, and the foothills of Jebel Marra. It is a strong flyer, and hard to catch. It flies round trees, such as the Camel Foot (*Bohinnia* sp.), frequently settling for short periods.

Genus Tarucus Moore.

Tarucus mediterraneae B-Baker. (Plate 9)

This species is coloured dark blue and brown with white markings

above in the female, and bright blue above in the male. The underside is white with dark brown markings. It is an extremely common and widespread species in the central Sudan, being usually found flying round *Sunt* trees when they are in flower.

Genus Castalius Hubn.

Castalius cretosus Butl. (Plate 9)

This species is white with black markings above. It is widespread in the thorn bush country, usually in small numbers, but may in some places be found thickly crowded on patches of damp earth.

Genus Azanus Moore.

Azanus ubaldus Cram. (Plate 9)

This species is pale smoky blue above, and grey with brown and black markings below. It is found widespread, in the central Sudan, sometimes very commonly on *Sunt* blossom, and on patches of damp earth ; it can fly very rapidly.

Genus Syntarucus Butl.

Syntarucus telicanus Lang. (Plate 9)

This species resembles *T. mediterraneae* above, in both sexes, but below has more dense brown markings. It also has the same range and habits.

Genus Pseudonacaduba

Pseudonacaduba sichela Wallengr. (Plate 9)

This species is blackish blue above, and nearly uniform grey below. It is found commonly during and just after the rains, from the Nuba Mountains to Jebel Marra, usually drinking on damp earth.

Genus Cosmolyce Tox.

Cosmolyce boeticus Linn. (Plate 9)

This species is brownish blue with pale markings above in the female, and violet blue above in the male. Below it is pale brown with brown markings, with a light band on the hindwing. It is a very widespread species, even occurring rarely in England, and can be found commonly on irrigated *berseem*, on which the larva feeds, as well as all over the country.

Genus Euchrysops Butl.

Euchrysops polydialecta B-Baker. (Plate 9)

This species is violet blue above, and pale brown with brown markings and black spots below. It is the largest of the common *Lycaenidae* usually met with, and occurs in small numbers widespread in thin bush country.

Euchrysops malathana Bsdv. (Plate 9)

This species is blue grey above, with an orange bordered black spot on the hindwing, and grey with brown markings below. It is a widespread species in the central Sudan, and may occur in very large numbers at drinking places.

Genus Freyeria (*Chilades* Moore)

Freyeria trochylus Freyer. (Plate 9)

This species is dark brown above, with orange spots on the hindwing, and grey below, with white bordered brown markings, and orange spots on the hindwing. It is widespread in the central Sudan, usually occurring in small numbers at drinking places.

Genus Zizeeria Chapm.

Zizeeria hylae Fabr. (Plate 9)

This collective name covers several nearly identical species which are purplish blue with a dark brown border above, and brownish grey with black and brown spots below. They are the commonest of the *Lycaenidae*, occurring everywhere.

Family *HESPERIDAE*.

Sub-Family *Ismeninae*.

Genus Coeliades Hubn.

Coeliades forestan Cram. (Plate 5)

This species is dull brown above, with a pale yellowish area on the hindwing, and has a white band on the hindwing below. It is a common species, occurring in small numbers widespread throughout the central Sudan.

Sub-Family *Pamphilinae*.

Genus Pelopidas Walker.

Pelopidas mathias Fabr. (Plate 6)

This species is dull brown above, and with small pale yellow windows. It is widespread and common, but is difficult to catch owing to its erratic and rapid flight.

Sub-Family *Hesperinae*.

Genus Sarangesa Moore.

Sarangesa phidyle Wlk. (Plate 5)

This species is mottled light brown above, and yellow with brown markings below. It is a common widespread species in the central Sudan, preferring shady places, and often occurring in large numbers in shaded holes in the ground, or the interior of dark huts.

Genus Spialia Swinhoe.

Spialia spio Linn. (Plate 5)

This species is brownish black with white markings above, and pale brown and white below. It is widespread in the central Sudan, but usually only occurs occasionally as single specimens.

FRESH WATER FISHERIES IN THE NORTHERN BAHR EL GHAZAL WATERS

By J. M. Stubbs.

THE waters referred to in these notes are those of the rivers Jur, Loll and Bahr el 'Arab with their tributaries, and the Bahr el Ghazal as far as Lake Ambadi and Jur River mouth lakes. I have no knowledge of conditions in the Lakes District or in that part of the Bahr el 'Arab running through the Nuer territory.

The upper, middle and lower reaches of the Jur and Loll form three different types of waters. In their upper reaches they are swift-running streams flowing down well defined wooded valleys. Their beds are composed of sand or gravel with frequent out-crops of granite and ironstone; waterfalls are rare but rapids are fairly common. In their middle reaches they emerge from the ironstone country to wind erratic courses through the thickly populated plains of the Nilotic tribes. In this sector the beds gradually change from sand to mud and many deep pools are scoured out by the action of the water. Backwaters and lakes, fed by the main streams, become more and more frequent until the rivers finally lose themselves in the vast uninhabited swamps of the Bahr el Ghazal. Conditions on the Bahr el 'Arab are much the same except that for the greater part of its course this river runs through uninhabited country. As these rivers approach their middle reaches, they are flanked on both banks by low-lying grass-covered plains from one to ten miles wide. These are subject to annual flooding in late summer and dry off in December. They are known as "*toic*" and provide the main spawning grounds for the fish of these waters. The Bahr el Ghazal is confined solely to the area of permanent swamps. Here the seasonal changes of water level are only a foot or so, but in their upper and middle reaches the rivers in winter dry up into pools connected by streams only a few inches deep.

All the waters of the middle and lower rivers abound in fish. Where they can be easily caught fish are an important item in the diet of the people who, during certain months, make fishing a communal occupation. These conditions occur in the thickly populated plains

of the middle rivers before the permanent swamps are reached. In the swamps, owing to a number of factors, the catching of fish with primitive methods is difficult and fishing is only carried on by a few professional fishermen. Natural reservoirs such as lakes and pools are few in the upper stretches of all rivers and consequently fish are not found in large quantities in these areas.

All the tribes of the area fish their home waters and there is no general taboo on fishing or on the eating of fish. The Dinka are by far the most proficient and energetic fishermen and the Aweil and western Raik tribes excel among these. Next come the Jur, Shatt and kindred tribes of the Shilluk-speaking family. Of the latter, mention should be made of the Mangangeer who provide most of the fishing clans of the permanent swamps. The Zande and mixed tribes of the Western District show comparatively little interest in fishing excepting the Ngulnguli and Indri, a subject tribe of the Feroge.

Of the Baggāra tribes the Habbanīya of the west make the most of the vast supplies of fish to be taken from the Bahr el 'Arab. The Rizeigat are also fishermen particularly in the *khors* running parallel to but north of the main river, but apart from a few Shatts living in their country, the Homr hardly fish at all.

In all cases the extent to which fishing is practised by the various tribes is subject to the supply of fish and the ease with which it can be caught. In the far west the supply is deficient. In the extreme east the fish are there in very large numbers but the dangers, discomforts and difficulties of catching them are great.

The fishing rights in most waters of the upper and lower rivers are owned by individuals or clans. Where an individual has the rights he collects tribute from those fishing his waters.

There are no marked seasons in the permanent swamps. In the middle rivers the *toic* flood in July and August to become vast spawning grounds. The floods recede in November and December when many of the fry and spawning fish are trapped as they attempt to regain the rivers. By January the rivers begin to form into a series of pools which in a good year boil with fish. These are systematically fished on a communal basis as soon as the hot weather begins in mid-March until the first rains in May. In June there is another short trapping season when the *khors* begin to fill and fish that have survived the dry season in the numerous swampy lakes are making their way back to the main rivers.

Methods of fishing vary with the different tribes and are here given separately under each tribe.

DINKA.—(i) Fry and spawning fish on the *toic* are caught by trapping. One of the peculiarities of our rivers is that their banks are generally higher than the level of the *toic* on either side. Ditches are dug in the banks to lead water into low lying basins where the fish go to spawn. As the rivers subside the ebbing flood-water is led by cunningly contrived banks through wicker baskets where the fry are trapped.

(ii) Fish are speared by blind spearing or on sight. The latter is the usual method in the clear waters of the permanent swamps and is also practised in the flooded *toic* where the presence of fish can be detected by a movement in the standing grass. Fish are also speared by sight at night with the aid of torches on a falling river in the shallow sandy stretches of water which lie between the deeper pools. Blind spearing is the usual method of fishing in the middle rivers during the dry season, and its success depends largely on the numbers engaged. The implement is the ordinary fish spear (*bieth*; *kokāb*) for use in the shallow reed-clogged *khors* and ponds, or the 18 foot long *yuai*, with a detachable head, used in the deep free waters of the numerous pools and lakes. The *yuai* is manipulated either from a dugout canoe or by a man standing, or by a swimmer in deep water added by an ambatch lifebelt.

(iii) An essentially women's method of fishing is with the *thoi*, or portable basket trap, which consists of a cone-shaped basket two foot six inches in height, open at the base, and with a small hole at the top. The basket is plunged blindly into shallow water and the imprisoned fish extracted through the top outlet.

(iv) The only form of net used by the Dinkas consists of a hammock-shaped net, 5 feet long by 3 feet broad, of 4 inch mesh slung on a rectangular frame and called an *alom*. It is generally operated by elderly married couples who stand chest deep in water with the net lowered and from time to time raise the contraption to see if there is a fish inside.

(v) Another method is with the *agot*. This is a barbed headed gaff with which a swimmer blindly sweeps the water in front of him. The head is detachable and secured to the shaft by a line by which a gaffed fish is played as it is drawn in to the bank. The Habbanīya use a similar implement.

The communal fishing of rivers is done by a combination of the last four methods. The young girls work the shallow waters on the edges of the pools. Next to them stand the net fishers and the elders who spear by sight with their *bieths*, while the young men fish the deep waters with their *yuai*. Given sufficient numbers, pools covering several acres can be cleared of fish by these primitive methods in a very short time.

These notes would not be complete without mention of Louth

" fishing." The habits of the Louth are too well known to need recording here but hunting for them in the dried up *toic* is one of the favourite pastimes of Dinka herdsmen. With the butts of their spears they tap the hard sun-baked mud to detect by sound the hide-outs of this curious fish, which they always find in prime condition, tightly curled, with their tails in their mouths.

Some foreign fishing methods have been introduced into the Dinka country. Chief among these is the fish hook which is mainly used to " sniggle " ground-feeding fish. The technique employed is to splice 4 or 5 pairs of hooks back to back on a line the end of which is weighted. The top hook is baited with freshwater oyster and the fisherman, generally a small boy, strikes continually with quite phenomenal success. The Egyptian throwing-net was first introduced into Aweil District some fifteen years ago and its abuse by the priviliged few so depleted the food of the many that it had to be first restricted and finally prohibited. Such nets are now worked by a few persons in the Raik and Twij countries but owing to war conditions they are becoming more and more difficult to obtain. Another and most successful way of catching fish has been learned from the Baggāra Arabs. This is the " Long Line " and will be described later. Baited night lines are also used in Aweil District and have more recently proved a successful method of fishing in the swamp area. Fish hooks, however, like imported nets, are getting very scarce nowadays.[1]

JUR.—(i) Autumn trapping is carried out. No earth works are made on the Dinka system, but basket traps are placed to catch the fish as they leave the drying khors.

(ii) Seine Nets. These are native made nets of about a 4 inch mesh some 60 feet long by 6 feet deep, supported by ambatch floats and weighted with ironstone. The method of use is that of the seine net.

(iii) By poisoning. This obnoxious practice can only be carried out in the smaller pools and therefore does less harm than is generally supposed. As a rule it is worked on a communal basis as the labour necessary to collect sufficient poison is considerable. Many types of poison are used, the most common being the bark of the *Balanites Aegyptioca* and the fruit of the *Randia Nilotica*. There is much conflicting evidence on the effects of poisoning pools; in those seen all the small fish including the minute fry were killed, but the bigger fish survived. The method is said to be non-injurious to human beings.

[1] This note was written in 1945.—*Ed.*

NGULNGULI & WESTERN DISTRICT.—The fishing methods of these tribes are similar to those of the Jur except that they make no use of the seine net. In addition they trap fish in the flood season by placing baskets in the rapids or under falls. Another method is to scoop out fish resting in the slack water of rapids with large and primitive prawning nets.

ZANDE.—I have no first hand knowledge of Zande fishing customs but understand that poisoning and all forms of trapping are the usual methods employed. In addition to this they are said to dam a falling stream and later obtain the imprisoned fish by emptying their artificial reservoir. This is interesting as it is the first step towards fish farming.

BAGGARA.—(i) "The Long Line." This is most efficient and consists of a line some 60 feet long from which hooks are suspended by 4 inch long secondary lines spaced every six inches. The line is either dragged up a river or through a pool by two men on opposite banks, or stretched during the night across a water a few feet below the surface. It is also most effective during communal fishing drives. The hooks are not baited and most of the fish caught are foul hooked.

(ii) The Jur system of trapping emptying *khors* is also used.

(iii) In the Habbanīya sector the many pools of the Bahr el 'Arab are fished communally by a mixture of blind spearing and "long line" methods, and further east the Rizeigat sometimes join the Dinkas to fish their bigger waters in the same way.

There are a number of professional fishermen who provide for the Wau market and fish the town waters of the river Jur with the seine net, Egyptian casting net and rod and line.

The only native method of preserving fish is by sun drying. The small fish caught in the fish traps on the *toic* are cleaned, sun dried and then broken up by pounding in a mortar and packed in cone-shaped baskets weighing about 50 lbs. each. The outside of the baskets are treated with locally manufactured potash as a protection against insects. The bigger fish caught in the winter are not boned, but cleaned and cut into strips and sun dried. They are then either sold separately by "the tail," or packed in bundles for export. The pounded fish cakes are said to keep better than the dried strips of larger fish. Fish oil is also extracted from the fatty organs of the larger fish.

The demand for fresh or dried fish is everywhere greater than the supply, and the dried varieties are eagerly bought by merchants for resale locally and for export to Wau and the Zande District. The supply

for commerce comes mainly from the fish traps of the *toic*, supplemented by fish caught on the Bahr el Arab during the winter season. Winter catches from the middle reaches of the Jur and Loll and all fish from the upper rivers are largely consumed when caught. Very little if any of the trade fish comes from the permanent swamps. The present price of dried fish paid to the producer is 30 m/m. per *rotl*. It is retailed in the spring for nearly twice this sum.

Very little of a scientific nature is known of the fresh water fish of the southern Sudan. Its great value as a supplementary food for the people justifies a full investigation, especially as it is admitted that ample supplies of fish would make good most of the deficiencies that exist in the diet of many of the tribes of the south west. The first requirement is therefore a scientific study of the problem with the object of protecting the vast fish reserves of the area and finding out the best way to make full use of this natural food supply. This is the work of an expert, but the following suggestions are offered from a layman.

The problems in the different areas should be treated separately. In the upper rivers the formation of the country lends itself to fish farming. Rivers and *khors* could be dammed at a small cost and the resultant reservoirs stocked with fish. The type recommended is a species which is found throughout the Bahr el Ghazal area and is the *tilapia* of East Africa. In every market in northern Uganda dried *tilapia* can be bought by the score for a few cents each. These have not the offensive smell of the Sudan dried fish and the species is one of the three best eating fish of our waters. It is suggested that the Uganda methods of catching and drying *tilapia* should be examined.

With the exception of a few waters, the thickly populated area of the middle rivers is, in my opinion, best left alone. It would be wrong to allow individuals, either traders or others, to corner the food of the inhabitants of this part of the country, which is what would happen if expensive improved methods of fishing were introduced. These are bound to come in time but let them come slowly and only after the supply of fish everywhere approaches the demand. The exceptions are certain crocodile-infested lakes or pools which are either taboo or reckoned too dangerous to fish. Such waters are, I believe non-existent in the middle Bahr el 'Arab, are comparatively few in Aweil District, but more numerous in the Jur River area. These might be fished by improved methods under licences issued to selected persons, preferably natives of the area.

It is in the permanent swamps that the main supplies of fish exist and it is there that fishing enterprise should be most encouraged. The

swamps present considerable difficulties and not least among these are the climatic conditions and the lack of bases for operations. Most of the normal European methods of fishing are unsuitable in this area. There are no hard banks and bottoms for operating seine nets; the great variety in the size and species of the fish make drifting gill nets impracticable, while in most lakes the "clear" water is so clogged with weed a few feet below the surface that trawling by net or line is impossible. However, a number of deep water channels and lakes exist and in these trawling under sail or mechanical power should be possible. For instance I believe that many tons of fish could be taken weekly during the flood season by a trawl net operating in the entrance to the Jur narrows at Lake Abu Shanab. Baited night-lines are already being used with advantage, but so far as I know the "long line" of the Baggāra Arabs has not yet been tried in the swamps. This method, which is employed in the lower waters of the Danube, might prove successful. It can be operated in weedy waters and has the advantage of being as deadly to vegetable bottom feeders as to cannibal fish. Another suggested method is the use of the Egyptian casting net and seine net in specially prepared areas which have been previously ground baited—*kwara* and *tilapia* as well as many other species can be easily caught in this way.

Finally, the protection and preservation of the fish supply must be considered. Newly established fish farms would have to be rigorously controlled during the tuition period, and harmful methods of fishing forbidden. In the waters of the middle rivers three species provide the main supplies of fish, which leave the *toic* in November weighing about 3 ozs. but by March average 1½ lbs. During December and January they swim in shoals and are particularly vulnerable to net and "sniggling" methods of fishing. A close season at this period would undoubtedly produce a heavier aggregate catch over the whole season and would conform to native custom before the introduction of foreign fishing methods.

At face value, the crocodile must be regarded as an undesirable rival by all fishermen and unless science can point to his uses the Government should take steps to reduce the numbers of these pests. The protection of their enemy the egg-eating monitor lizard, and a study of their breeding habits would probably be the best line to adopt in achieving this end.

NOTE.—Attention is drawn to the forthcoming illustrated handbook on Nile Fish, to which reference is made in the Editorial Notes.—*Ed.*

SMALL MAMMALS OF THE SOUTHERN SUDAN

By A. B. Anderson.

THE small animals of the Class *Mammalia* are divided into the following Orders :—

1. *Insectivora.*	Elephant shrews, Golden Moles, Hedgehogs, Shrews.
2. *Chiroptera.*	Bats.
3. *Primates.*	Lemurs, Monkeys, Man.
4. *Carnivora.*	Weasels, Dogs, Otters, Civets, Mongooses, Genets, Cats, etc.
5. *Nomarthra.*	Pangolins.
6. *Tubilidentata.*	Ant bears.
7. *Rodentia.*	Gnawing mammals. This is the only order in which the incisors are greatly enlarged. In other orders such as the *Insectivora* the canines are large.
8. *Hyracoidea.*	Hyrax.

These Orders are described below under these numbers.

ORDER No. 1. The *Insectivora* are split into the following Families :—

A.—*Macroscelididae,* or Elephant Shrews, of which there are a number of Genera. *Elephantulus* is probably the commonest Genus and its members are mouse-like creatures with the body about the same length as the tail. They have a trunk-like appendage at the end of the nose (which is not slit at the end) and which in life is kept perpetually in motion, wiggling about. *Rhinonax,* which may not exist in the Sudan, has a body a rich chocolate colour about 12″ long and a tail 8″. Other Genera have a body of 4″ to 7″. Dental formula :—$\frac{0-1-4-2}{3-1-4-2}$ or 3.

B.—*Chrysochloridae.* Golden Moles live at 8000 ft. and above and it is doubtful if they exist in the Sudan. They lead a subterranean life and are quite blind, the eyes being covered with skin. They have beautiful irridescent hair mingled with their soft fur.

C.—*Erinacidae.* The common four-toed hedgehog (four and a claw on the rear foot) is *atelerix pruneri.*

D.—*Soricidae*, or Shrews, are in great variety throughout Africa. About 160 species and sub-species of the genus *crocidura* alone are listed. Shrews are mouse-like creatures with a slight trunk-like nose which is split at the end. Like all the *Insectivora* their incisors are small or absent but their canines are large.

ORDER No. 2. The Order of *Chiroptera* is split into the following Families :—

A.—*Pteropidae*. Fruit bats.

B.—*Rhinopomidae*. Mouse tailed bats.

C.—*Emballonuridae*. Sheath tailed bats.

D.—*Nycteridae*. Hollow faced bats.

E.—*Megadermidae*. Big eared bats. It includes the genus *lavia*, the large yellow semidiurnal bat often seen in dry srub.

F.—*Rhinoloppidae*. Horseshoe bats. This family has a very frilly face.

G.—*Hipposideridae*. Horseshoe bats. The term refers to the contour of the face. Common in rest houses.

H.—*Vespertilionidae*. Simple-nosed bats.

I.—*Molossidae*. Free-tailed bats.

(Bats have a very wide range and excellent practical descriptions of these families are given in Shortridge's *Mammals of S.W. Africa* and are therefore not given here).

ORDER No. 3. The Order of *Primates* is divided into two Sub-Orders, the *Lemuroidea* and the *Anthropoidea*. The Sub-Order *Lemuroidea* consists of the following Families :—

A.—*Lorisidae*. The pottos or slow short-tailed lemurs. The tail is almost rabbit-like, whilst in the galago it is longer proportionately than a cat's. It is doubtful whether the potto exists in the Sudan,

B.—*Galaginae*. The long-tailed bush-baby from the savannah probably differs from the one on the Imatong Mts.

The Sub-Order *Anthropoidea* consists of the following Families :—

A.—*Cercopithecidae*. Monkeys and apes are divided into the following genera :—

1. *Cercocebus*. Mangabey. A black mangabey may exist in the Imatongs.

2. *Cercopithecus.* The silky monkeys are divided into :—
   (*a*) *C. aethiops.* The vervet, grivet or small green monkey. Savannah.
   (*b*) *C. mitis.* The blue monkey. Forest : South.
   (*c*) *C. neglectus.* Obtained by Petherick on White Nile.
   (*d*) *C. nictitans.* Heart-nosed monkey. Forest ; South ; has a white heart-shaped furry nose, the rest being blackish.
3. *Eurithrocebus.* The large Patas or Red Hussar monkey. Savannah.
4. *Comopithecus hamadryas.* Hamadryas baboon. Eastern border and Ethiopia.
5. *Papio doguera.* Common baboon.

B.—*Colubridae* or leaf eating monkeys. There are two colubus : *colubus polykomos dodingae* from the high forests and *c. p. uelliensis* from the low altitudes.

C.—*Pongidae.* The long haired chimpanzee *pan troglodytes schweinfurthii* exists in Zande District.

ORDER No. 4. The order of *Carnivora* is split into the following Families :—

A.—*Mustelidae.* The weasels are subdivided into the following genera :—

1. *Ictonyx striatus.* The African striped polecat, is whitish with three black stripes running from the forehead to the base of the tail about $\frac{1}{2}''$ wide. Tail is well covered with fur, white outside with grey underfur. Belly black with the skin showing through. 5 toes, small round ears, dog-like teeth. Pm $\frac{3.}{3.}$ M $\frac{1.}{3.}$ Body and head 13″. Tail 10″.
2. *Mellivora capensis.* The Ratel or Honey Badger has a head and body about 2′6″ long and a tail about 12″. It is quite unmistakeable as its coloration is in three decks—from top to bottom grey, white, black. Dental formula the same as the polecat. This animal is quite fearless and a very ugly customer. An immature Sudan specimen was a two decker—grey above, black below.
3. *Poecilictis libyca,* African striped weasel, " is long and lithe and typically weasel-like. When in slow progress over the ground it reminds one forcibly of a caterpillar, the back being arched or humped up in a similar manner." (Shortridge). It is very rare and bears a resemblance to *ictonyx.*

4. *Aonyx capensis*, the clawless otter. The otters are generally classified as a sub-family *lutrinae* but are included here for convenience. This otter has very round face and feet ending in 5 longish toes which are not webbed, and total lengths of over 1 m. 30 have been recorded. Possibly in Zande District. Colour dark brown. Short fur.
5. *Lutra maculicollis nilotica*. The web-footed clawed otter has been recorded from Malek and may be as big as 3′ 6″. The toes are webbed right out to the claws.

B.—*Canidae*. Dogs, Jackals, Foxes, are split up as follows :—

1. *Lycaon pictus*. Hunting dog.
2. *Thos aureus soudanicus* is the typical northern jackal. *Thos mesomelas*, the black-backed jackal, is found on the plains east of Kapoeta and *thos adustus*, the sidestriped jackal, may also occur in the South.
3. *Vulpes pallida*. The Red Fox occurs in Kordofan.

C.—*Viverridae*. This Family is divided into two Sub-families, the *viverrinae* Civets, Genets etc. and the *herpestinae*, the Mongooses, but neglecting this division the whole Family may be split as follows :—

1. *Civettictus civetta*. The civet is a large heavy dark spotted and splotched animal with 5-toed feet. Head & body 41″. Tail 14″. Normally coloured specimens have a black nose set in a patch of white fur a couple of inches wide. Above this is a dark patch, right over that part of the front of the head where the eyes are, down to the throat. Forehead light grey. Owing to the presence of musk glands the genitalia of these animals are very curious. The young make excellent pets. Melanism is not uncommon.
2. *Genetta tigrina*. In the genet, which looks rather like a cross between a cat and a weasel, the tail is nearly as long as the body which may be 20″. Grey with two or more lines of spots longitudinally. Face ferret-like. About nine dark rings round tail. " Shoulder height 20 cm. " " The claws are semiretractile, small and of little use in defence. Mammae 4." (Shortridge).
3. *Nandinia binotata*. In the Palm Civet the tail is even longer than the body and has 12 irregular bars on top of the body-half of the tail, though they are not always present. It has a cat-like face and thick brown fur irregularly spotted with black. A distinct white spot is present on each shoulder—hence its specific name. Head & body 19½″ Tail 21″. They make excellent pets

but take to chicken killing when adult. May be found in Zande District.

4. *Atilax paludinosis.* The large Marsh Mongoose is very common, in suitable areas. It has a dark almost black body with lighter spots. Head & body 24". Tail 14". Tail tapers. Belly brown. 5 claws. Thumb rudimentary.
   Dental formula : $\frac{3-1-2-2}{3-1-2-2}$.
5. *Dologale dybowski.* A mongoose recorded from Moru District.
6. *Galerella ochracea.* "Ethiopia to N.E. Congo." (J. A. Allen).
7. *Helogale hirtula.* Short-tailed dwarf mongoose from N. of L. Rudolf.
8. *Herpestes ichneumon.* Large grey mongoose.
9. *Ichneumia albicauda.* White-tailed mongoose. Fairly common.
10. *Mungos mungo.* The common barred mongoose kept as pets by Azande.
11. *Myonax sanguineus.* A northern mongoose from Kordofan with a black-tipped tail.

D.—The Family *protelidae* has only one representative—*proteles cristatus.* This is a queer degenerate creature related to the hyenas and comparison of their skulls is interesting. *Proteles* has taken to insect eating and has no back teeth but still has powerful fighting teeth. High at the shoulder like a hyena but about the size of a fox terrier. Legs very spindly. Black muzzle. Stripes on back. Spends most of its time underground.

E.—The Family *felidae,* the Cats, is split as follows :—

1. *Aconyx jubatus.* Cheetah.
2. *Caracal caracal.* The African Lynx.
3. *Felis lybica.* The sacred cat of ancient Egypt. The grey wild cat is more strongly built than the domestic cat. Hybrids with domestic cats generally remain as wild as their wild forefathers.
4. *Felis serval.* Height at the shoulder 50-60 cm. Weight about 30 lb.

ORDER No. 5. The Order of *Nomartha* consists of only the scaly ant-eaters called pangolins, of which there are three kinds. The Giant Pangolin is called *smutsia temminckii* and the two smaller arboreal ones *phataginus tricuspis* and *uromanis longicaudata.*

ORDER No. 6. The Order of *Tubilidentata* contains only the ant-bear *orycteropus afer.*

ORDER No. 7. The Order of *Rodentia* contains an interminable number of Families, Sub-families and Genera. This Order can only be outlined here.

A.—*Leporidae.* Hares and Rabbits.

1. *Lepus* contains both the long-eared and the short-eared hares. There are at least 3 species in the Sudan.
2. *Poelagus marjorita larkeni.* The Zande rabbit. There is also possibly a rabbit from high heath called *pondelotis.*

B.—*Anomaluridae.* Spiny-tailed flying squirrels have been reported from the forests near Yambio and also from the Imatong forests in Torit District. It is possible that they belong to the Genus *jacksoni* which exists in the N.E. Congo. Allen gives their average measurements as total length (males) 549 mm., Head & body 317, Tail 232 and females total length 562, Head & body 331, Tail 251.

C.—*Sciuridae.* The Tree and Ground Squirrels.

1. *Euxerus erythropus lacustris* is the bushy-tailed wire-haired ground squirrel with a light sidestripe. The northern form is *E.e. leucombrinus.*
2. *Helioscurus multicolor.* Tree squirrel, though it nests in holes in the ground.
3. *Tamiscus emini gazellae.* African Striped Squirrel.

D.—*Muscardinidae.* The bushy-tailed dormouse that darts about at night outside the mosquito wire of one's veranda, catching insects, is *graphiurus.* The experts are undecided as to the species.

E.—*Cricetidae,* Maned Rat. A very rare bulky hamster-like rodent with a white stripe down the side, and a bushy tail. Head & body up to 290 mm., Tail 215 mm. Must not be confused with *cricetomys gambianus,* the Giant Rat, which belongs to the Muridae or typical rats and is a grey rat which may have a Head & body 320 mm. and Tail 300 mm. which is bare.

F.—*Gerbillinae.* "Gerbils are essentially mammals of the sandy plains, adapted as they are with their long hind legs to cover fairly long distances to reach their feeding grounds" (Shortridge, from Roberts). There is one species of *desmodilliscus* and about 10 of *dipodollus.* Also 2 species of *gerbillus,* several species of *tatera* and 9 species of *taterillus*

in the northern Sudan. One species of *tatera* has been obtained in the Bahr el Ghazal and one of *taterillus* at Wadelai in Uganda.

G.—Otominae. The groove-toothed rats have been obtained from Mt. Elgon and N.E. Congo, but no Sudan records have been published.

H.—*Dendromurinae.* Small tree mice. The Fat Tree Mouse *steatomys gazellae* has been recorded from Zande District.

I.—*Muridae.* Typical Rats and Mice.

J.—*Bathyergidae.* Mole rats may be distinguished from moles by their powerful incisors which reach far back into the head and keep on growing during the life of the animal. The true mole being an insectivore has the canines and not the incisors developed. The Zande species of mole-rat has been described as *cryptomys ochracea-cinereus.* (*Lechei* may also exist).

K.—*Thryonomyidae.* The cane rat *thryonomys swinderianus* is a big heavy animal the size of a hyrax. It is however a rodent and has a tail.

L.—*Atherurus centralis.* The brush-tailed porcupine has been reported from Zande District and from the Imatong Mts. It is a rare nocturnal forest animal and is seldom seen. It is smaller than its relative *hystryx* but has a longer tail with a tuft of bristles at the end of it. The spiny covering of the back is not so highly developed as that of *hystryx* which has a short tail bearing a cluster of hollow quills with which it makes a rattling noise. Asian species of *atherurus* are said to be able to imitate this noise but probably not *A. centralis.* In some Asian species the back bristles have not been specialised into quills.

M.—*Hystricidae.* The old-world Porcupine.

ORDER No. 8. The Order of *Hyracoidea* contains only the Tree Hyrax and the Rock Rabbit, or Dassie. It is very difficult to distinguish between them, but if the rock hyrax is held up to the light it will be seen that every inch or so there is a long stiff hair sticking a long way out above the coat. These are presumably sensory organs to guide the animals in dark rock crevices. The common dassie is *procavia ruficeps.*

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(The systematical part of this paper is lifted straight out of Allen's invaluable Checklist which I have followed as closely as possible, adopting scientific names used by him.
Descriptions of animals, except those acknowledged, are from specimens obtained by the writer in the Sudan or from specimens in the Coryndon Museum, Kenya Colony).

Note on scientific classification.

An animal such as *lutra maculicollis nilotica* belongs to the Genus *lutra* Species *maculicollis* Sub-species or Race *nilotica*. The Genus *lutra* belongs to the Family *mustelidae* of the Order of *carnivora* of the Class *mammalia*. Where only two names are used such as *mellivora carensis* then *mellivora* is the Generic name and *capensis* is the Specific name.

VERNACULAR LITERATURE IN THE SOUTHERN SUDAN SINCE 1940.

By S. G. Clutton.

Sudan Ministry of Education.

THE Sudan south of the 12th parallel, from a line through the Nuba Mountains southwards to the Congo-Uganda borders, is a country with wide scope for language research. There is the meeting place of three main language families, the Sudanic predominating in the West, the Nilo-Hamitic in the South-east, with between them the wide wedge of the Nilotic peoples.

The number of languages encountered is bewildering. In the small area of the Nuba Mountains there are ten language groups; fourteen distinct languages are encountered along a stretch of road running two hundred miles from Wau to the west. The dialects are even more numerous, Dinka alone having four principal dialects differing not merely in vocabulary but also in construction. Before there can be any production of literature in these languages there are many questions of orthography and spelling which have to be settled and this involves careful and arduous research.

While, in spite of the difficulties of the War years, valuable contributions have been made by interested Government officials, the great bulk of the work has been done, as in many other parts of Africa, by individual missionaries. Of outstanding merit is the work of R. C. Stevenson in the Nuba Mountains. He has set himself to check the investigations of previous workers such as Kanczor, Junker and McDiarmid, to widen them by a more detailed study of specific languages, and to obtain a more precise picture of linguistic relationships in the field. Stevenson, who modestly calls his work " spare time," has investigated languages and dialects in all of McDiarmid's ten groups and has produced grammars in three of them. His more recent work on the Dagu and Nubian groups was done with the hope that, in collation with other dialect material from Darfur, it might contribute to the comparative study of those language groups.

The Rev. Father Santandrea, with the help of a grant from the International African Institute, has been investigating the Sudanic language groups to the west of Wau. He has done valuable work on such languages as Binga, Kreish and Yulu. Acknowledgement of Father Santandrea's earlier work in the Bongo and Ndogo-Sere language groups is made in the comprehensive survey of the Eastern Sudanic Languages by Dr. Tucker which was published in 1940. Dr. Tucker will be conducting further research in the Kreish and other languages when he revisits the Sudan in June of this year.[1] It is interesting to note that he is bringing a team of experts to complete the survey of the Bantu line, which runs close to the southern borders of the Sudan as the northern boundary of the Bantu speaking peoples.

There have been some notable publications as the result of intensive study in the Nilotic and Nilo-Hamitic languages. For the northern Dinka Dr. Trudinger completed his dictionary, which is a very fine piece of work. Not only is it comprehensive with a liberality of examples but also the tones of every word are marked. For the Western Rek dialect of Dinka, Father Nebel's Grammar was published in 1948 and has won high commendation. Mention must be made too of the fact that Archdeacon Shaw, apart from his monumental task of rendering the Scriptures available in the Bor Dinka dialect, has found time to examine the problem of adopted words.

In the Nuer language Father Kiggen has completed the work begun by Father Crazzolara, and his Nuer Dictionary, printed in Holland, has now been published. With great labour Father Kiggen revised the whole of the dictionary, putting it into the central Thiang dialect which has been chosen as the literary standard for all Nuer speakers.

For the south-east, where the Nilotic Acoli meet on our borders a group of Nilo-Hamitic tribes, two valuable dictionaries have been produced. The Rev. Father Spagnolo, whose Bari Grammar was published in 1933, completed his Bari-English Dictionary, and the Rev. Father Muratori expanded an English-Bari Vocabulary of Mrs. Gibson to produce an English-Bari-Lotuko-Acoli Vocabulary which was printed at the Mission Press, Okaru.

On the borders of Ethiopia, in the region described by Miss Bryan as the "Linguistic No Man's Land," very much research remains to be done. In the north-west the Rev. Paris Reidhead and his wife studied the languages south of Kurmuk, such as the Koma dialects, Maban, Uduk and Fum-fum. These two workers were trained at the

[1] The year 1949.—*Ed.*

Summer Institute of Linguistics, California, under Doctors Townshend, Nida and Pike. The course given there is short, intensive and very well planned, and the textbooks issued by the Institute on Phonetics, Morphology and Translation are valuable contributions to the literature available to students of linguistics. Dr. Nida visited the Sudan in 1948.

Further south B. A. Lewis and R. J. Lyth have contributed work of considerable value in studying the Murle language and have produced a grammar which it is hoped to print in the Southern Publications Bureau this year. The language is akin to Didinga and further research is planned to determine whether a common literary dialect may perhaps be adopted. Apart from the above outstanding pieces of work, acknowledgement must be made of the many useful compilations and verifications of information made by District Commissioners, missionaries and others to assist Miss Bryan in her survey of the Ethiopian border areas.

Having outlined the accomplishment of the past eight years, it would seem useful to consider the present organisation for the correlation of language reserch in the South. In 1940 a Language Bureau was established at Southern Education Headquarters for the co-ordination of language study. This Bureau was responsible for the setting up of group language committees. The functions proposed for these committees were the promotion of research agreement on matters of orthography and spelling and the promotion of vernacular literature. These committees achieved agreement on all important matters of orthography and spelling in the following groups: Dinka, Shilluk, Nuer, Zande, Bari, Lotuko and Taposa. The committees met under the chairmanship of the Chief Inspector of Education, South, G. E. Janson Smith, whose personal interest and enthusiasm in language study smoothed the path through many difficulties and helped to maintain a considerable impetus in research and in the production of text-books and other literature. Provision was made for expert advice and arbitration, as a result of which valuable assistance was rendered by Dr. Tucker of the London University School of Oriental and African Studies whose pioneer work on the orthographies of Shilluk, Nuer, Dinka, Zande, Moru and Madi did so much to lay sound foundations.

The Sudan Government gives a grant to works which will be used over the whole of one language area, the amount being regulated to bring the price of a book down to that which may reasonably be afforded by the Sudanese for whom it is intended. Under the stimulus of these committees and the grants offered, some thirty books and pamphlets have been produced each year.

1949 and Future Development.

With the arrival of S. G. Clutton as Language and Publications Officer and the transfer of Gordon A. Ayom, a Dinka with much experience of translation, to the Bureau at the end of 1948, it is hoped that progress may be accelerated considerably in the solution of language problems and in the provision of vernacular literature. With full-time workers and the small rotary lithographic press which has been installed, the production of textbooks, in particular for the language groups whose numbers are so small that commercial publishers could not economically undertake production, should be greatly facilitated. This year a series of primers is being produced. Six of these, of which one is now in use and a second almost completed, are designed to bridge the transition from illiteracy to the use of English as a medium of instruction for the smaller tribes in the Wau area. Others include a Nuer primer, adaptations of Dinka from the Padang to the Bor dialect and printings of Shilluk readers which have hitherto been duplicated by hand.

But one problem which has evidently caused anxiety to Government officers and missionaries alike, is the possible lapse into illiteracy of the large numbers who leave school after only two to four years' schooling. To combat this the Bureau hopes to publish a number of inexpensive booklets in the vernaculars and in English. These will be designed to widen the horizons and to improve the living standards of the southern Sudanese on the one side, on the other to foster the appreciation of reading as a recreation. Access to reading matter is difficult even to the better educated, and in April the Bureau published the first number of a Teachers' Quarterly Magazine which is intended to provoke thought and discussion perhaps in a wider circle of the people. In addition to the publications mentioned above, the Southern Bureau between February, when the machine was first in operation, and May 1949 has produced two pamphlets (one on Nutrition of Africans, the other on the Government of the Sudan), and the Arabic version of a picture vocabulary. It has also gestetnered two Arithmetic textbooks for issue to teachers and the 185 page " Ways of Living in the Sudan " which was produced at the Institute of Education, Bakht er Ruda.

On the linguistic side of the Bureau's activities the emphasis will be on comparative studies and standardisation which are essential to the economic production of books and their wider availability in greater numbers. There are very hopeful signs that a more liberal view is being taken by those who have in the past allowed their affection for their particular dialect to lead them to oppose the selection of

another as a main literary medium. More are beginning to appreciate that the survival of a tribal language is connected with the number who speak it and the extent of its literature. As an example, resulting from an informal meeting in February of Dinka speakers of various dialects, it is probable that arrangements will be made for teachers to make comparative studies in other dialect areas during the coming year. A comparative Dinka Vocabulary, which is almost completed, will be printed, and it is hoped that Dr. Tucker will be producing a comparative Dinka Grammar.

One of the greatest difficulties likely to be encountered, however, is in the staffing of the Bureau with men of a sufficiently high standard of education who are capable of being trained as translators. The demand for Sudanese of such calibre in the Education and other Departments is considerable. Experience on the West Coast suggests that ten years is a minimum time in which an efficient translator may be produced, so that it is vitally important that no time shall be wasted. Meanwhile the gap may perhaps be filled to some degree by the encouragement of original composition by Sudanese in their vernaculars, which is a desirable aim in itself, as leading to the development of a native literature.

Bound up with the whole intricacy of language differences in the southern Sudan is the necessity for an adequate *lingua franca* for the purposes of administration, commerce and higher education. Past history has made a very debased form of Arabic, poor in vocabulary, a medium for the first two and English for the third. The concept of closer relationship between north and south in a united Sudan makes it most important that at least the better educated should in a very short time become proficient in Arabic. In July a working party is assembling at the Southern Publications Bureau in Juba to study and initiate the production of Arabic textbooks for the South. This will lay the foundation for the extension of Arabic teaching into schools of all grades, a formidable task in the provision both of teachers and of textbooks. The reward however will be great in providing a means of communication for everyday affairs which should ensure greater sympathy of understanding and ability to cooperate between the peoples of the northern and southern Sudan.

CAVES IN THE SANDSTONE HILLS NORTH OF OMDURMAN

By R. A. Hodgkin

Sudan Ministry of Education.

THERE are alleged to be caves of very considerable size in some of the Nubian sandstone hills of the Merkhiyat group to the north-west of Omdurman. I have, however, never come across any such caves. But there is a small group of hills called Jebel Abu Wiledat which contains a cave of considerable interest. These hills consist of three sandstone pyramids with a slight step effect caused by hard and soft beds of horizontal strata.

In the south eastern corner of the most easterly hill there is an inconspicuous cave whose mouth is about eight feet high. The cave narrows rapidly and bends to the left so that its length is not at first evident. One has to crawl first on all fours and later in a prone position in order to penetrate the most narrow section. L. W. Brown and I managed in this way to wriggle into an inner chamber between thirty and forty feet from the entrance. Large numbers of bats whizzed past us in a disconcerting manner and the ammonia-like stench of bats was so strong inside that we were loath to prolong our investigations. In 1947 M. M. Legge and I made a more extensive exploration of the whole cave. This time the bats were fewer. We also brought a hurricane lamp whose steady flame assured us that the air, despite its smell, would be breathable.

We found that the inner chamber was about ten feet high and ten feet long. From it branched several other passages. Most of these dwindled away into impassable cracks. One passage, however, proved to be extremely interesting: it was about 30 feet long and from three to five feet high. A long trunk of fossilized tree lay along its whole length, a broken portion of which occupied the floor of the chamber. Its dimensions were roughly those of a large telephone pole and there was no indication of any branches. Like most fossilized wood it was much harder than the surrounding sandstone which was quite friable.

We found no human remains anywhere in the cave, but there were a number of bones and some pieces of dried skin which indicated former animal occupants. Bats seemed to be the only present inhabitants.

It is difficult to understand what could have formed these caves. The irregular nature of the cave floor seemed to preclude the possibility of any form of water erosion. The narrow entrance put wind-scour out of the question. This extreme narrowness and the absence of human remains made it unlikely that men could have been responsible. The only remaining possibility seemed to be that animals and bats must have been the cause. Wind may also have helped in the original excavation of the more open entrance. In other parts of these hills it is common to see shallow caves whose back walls appear to have been scraped and deepened by animal occupants. Two other facts seemed to support the animal theory. The smaller passages are characterised by a cross-section which resembles a large key-hole. There is a narrow track which would allow for the passage of feet and a larger space at the top which would allow the body of a quadruped to pass along. I am inclined to ascribe the larger dimensions of the central chamber to bats. We saw a number of these hanging to the roof, and the roof itself appeared to be marked by numerous small concavities, which might be the resting places of bats. It is possible that innumerable bats clinging into the friable surface with their claws may have pulled away sufficient particles of dust to enlarge the chamber to its present proportions. This postulation of bat erosion may seem rather far-fetched, but in default of any more likely hypothesis I think it should be allowed to stand.

BLOOD GROUP PATTERNS IN SUDANESE

By N. L. Corkill.

Late Sudan Medical Service.

In 1942-1944 Sudanese troops of the Sudan Defence Force serving in North Africa had their bloods grouped as a routine. The purpose of course was that the soldier's group could be stamped on his identity disc, then, if he became a casualty and required a blood transfusion, his blood group might be at once known. This grouping was done for the 1st S.D.F. Infantry Brigade by the officers of No. 40 (S.D.F.) Light Field Ambulance, and the writer, who was in command of this unit, kept the records and supplemented them later from the regimental rolls of certain units of the successor formation, the 12th (S.D.F.) Division. The object was publication in due course, as it was believed that no reports of Sudanese blood group patterns had so far been published.

TABLE 1.—SOME RACIAL BLOOD GROUP PATTERNS (*ADAPTED FROM WIENER* (1946).)

RACE	Group %				RACE	Group %				RACE	Group %			
	04	A2	B3	AB1		04	A2	B3	AB1		04	A2	B3	AB1
Peruvian (pure)	100	—	—	—	Lapp	29	63	4	4	Chinese	33	22	34	11
Maya	98	1	1	—	Hawaian ...	36	61	2	1	Hindu	31	19	41	9
Australian aborigine	53	45	2	—	Eskimo	24	56	11	9	Dravidian ..	24	28	37	11
English	50	39	8	3	Armenian ..	27	53	14	6	Ainu	12	29	34	25
Icelander	56	32	9	3	Portuguese ..	38	53	6	3	Pygmy (Efé)	31	30	29	10

Table 1 adapted from Wiener (1946) shows some peculiarities of blood group patterns in the world at large, notably the peculiar dominance of the 0 group in American aboriginal stock and the equally striking dominance of the B group in certain Asiatic peoples.

Table 2 shows the patterns in Sudanese military units, and also in tribal or racial groups collected together from a pool of individuals contributed to by several of these units. Only the larger numerical series are given, and of these probably only the Shaigīya, Ja'alīyīn and Dilling-area Nuba should be taken as giving an acceptable picture.

TABLE 2.—BLOOD GROUP DISTRIBUTIONS IN SOME SUDANESE MILITARY UNITS AND TRIBAL OR RACIAL GROUPS

COMMUNITY	Number in Series	Group percentage (number in brackets)							
		04		A2		B3		AB1	
2nd S.D.F. Motor Batt. (Very mixed : Gedaref area) ..	(323)	(121)	38	(85)	26	(76)	24	(48)	11
4th S.D.F. Motor Batt. (Riverain Arab : Shendi area) ..	(598)	(284)	45	(163)	27	(137)	25	(14)	3
7th S.D.F. Inf. Batt. (Mostly Diling area Nuba)	(626)	(283)	47	(192)	30	(125)	20	(26)	3
8th S.D.F. Inf. Batt. (Very mixed : Gedaref area) ..	(522)	(234)	45	(141)	27	(137)	26	(10)	2
56th S.D.F. G.T.C. Coy. (Mixed Khartoum)	(337)	(167)	50	(98)	29	(59)	17	(13)	4
No. 40 (S.D.F.) Lt. Fd. Amb. (Mixed-Khartoum)	(183)	(91)	50	(52)	28	(39)	21	(1)	0.5
No. 1 (S.D.F.) Fd. Hyg. Sect. (Mixed-Khartoum)	(207)	(88)	43	(46)	22	(64)	31	(9)	4
1st S.D.F. Brig. H.Q. and Signals (Mixed-Khartoum) ..	(187)	(91)	48	(47)	25	(45)	23	(4)	2
Bani 'Amer	(89)	(37)	42	(20)	22	(23)	26	(9)	10
Dilling-area Nuba	(380)	(168)	45	(130)	34	(66)	17	(16)	4
Dinka	(56)	(27)	49	(16)	28	(8)	14	(5)	9
Danagla	(63)	(27)	43	(18)	29	(14)	22	(4)	6
Fur	(77)	(36)	46	(19)	25	(19)	25	(3)	4
Ja'aliyin	(206)	(105)	51	(55)	27	(38)	18	(8)	4
Shaigiya	(432)	(192)	44	(111)	26	(106)	24	(23)	5
Ta'aisha	(77)	(33)	42	(24)	31	(14)	18	(6)	7

The 4th Motor Battalion with its large content of Shaigīya and Ja'alīyīn may be taken as representative of Sudan riverain Arabs and the relatively high level of the B group may be noted. The 7th Infantry Battalion was entirely Nuba, mostly from the Dilling area, and here there is relatively less B and more O and A. In general however, where the series are large, the pattern in all units and all tribes and races is similar and would seem to reflect the mixture of African and Asian blood which has occurred. Table 3 suggests that on the whole it is towards the African type that the patterns tend, that which is found in the Ethiopians, the Bantu and the Congo Negroes, rather than that of the Egyptians and the " Arabs " of Syria and Baghdad. Adequate series in pure Arabs have not yet been done.

TABLE 3.—SOME BLOOD GROUP PATTERNS OF SUDANESE AND POPULATIONS ADJOINING THE SUDAN (*PARTLY ADAPTED FROM WIENER* (1946).)

Adjoining Race or Tribe	Group %				S.D.F. Unit	Group %				Sudan Race or Tribe	Group %			
	04	A2	B3	AB1		04	A2	B3	AB1		04	A2	B3	AB1
Turk ..... (Constantinople)	34	42	15	9	No.2 Batt. ..	38	26	24	11	Bani 'Amer..	42	22	26	10
Egyptian	24	33	29	14	No. 4 Batt....	45	27	25	3	Danagla	43	29	22	6
Cyrenaica Arab.	45	33	18	4	No. 7 Batt....	47	30	20	3	Ja'aliyin	51	27	18	4
Beirut Arab....	34	37	18	11	No. 8 Batt. .	45	27	26	2	Shaigiya	44	26	24	5
Baghdad Arab	34	31	29	6	No. 56 G.T.C.	50	29	17	4	Ta'aisha	42	31	18	7
Ethiopian	43	27	25	5	Various smaller units	47	25	25	3	Fur	46	25	25	4
Bantu	54	24	20	2						Dinka	49	28	14	9
Congo Negro ..	41	27	26	6						Nuba (Dilling area)	45	34	17	4

Table 4 shows the pool of races and tribes deriving from the various units. The majority of the series are too small to be of any but possibly suggestive interest but the table is published as providing nuclei round which further figures may accrete. It would be interesting to collect of the order of 200 each, relating to the Hawawir, the Hadendowa, the Shilluk, the Nuer, the Dinka, the Ingessana, the various Nuba groups, the Zaghawa, the Fur, the Zande and of course many others.

TABLE 4.—BLOOD GROUP PATTERNS IN SUDANESE RACIAL OR TRIBAL GROUPS COLLECTED FROM AN ANALYSIS OF POOLED RECORDS FROM CERTAIN MILITARY UNITS OF THE S.D.F. 1942-44.

Race or Tribe	04	A2	B3	AB1
Ababda	7	6	6	—
Albanian.....	—	1	—	—
Arakiyin	—	—	—	1
Arteiga	1	—	—	—
Bagirma	1	—	—	—
Banda	2	—	—	—
Bari	—	4	—	—
Baggara	3	2	1	—
Batahin.....	3	1	1	—
Bedeiriya	—	3	1	—
Bani 'Amer...	37	20	23	9
Berberi ..... (Nubian)	—	—	—	1
Bargo	21	12	5	4
Berta	2	2	2	1
Bilal.....	—	1	—	—
Birgid	—	—	1	—
Bisharin	1	—	—	—
Borno	10	5	12	—
Copt	—	—	—	1
Dagu	3	4	3	—
Degheim.....	—	—	—	1
Dinka	27	16	8	5
Danagla	27	18	14	4
Dubar	—	1	—	—
Duweih.....	1	—	—	—
Ethiopian ...	—	1	—	—
Fadliyin	—	—	1	—
Fallata	9	3	1	—
Fertit	1	1	—	—
Fitihab	—	2	1	—
Fung	4	3	3	1
Fur	36	19	19	3
Gawama'a ...	4	1	1	—
Gabr	1	—	—	—
Gima'	1	—	—	—
Gamai (possibly Gawama'a)	19	10	10	2
Gebelawiyin .	—	2	1	—
Gedain (?) ...	—	1	—	—
Gellaba (?) ..	3	1	—	—
Gim'ab	1	1	—	—

Race or Tribe	04	A2	B3	AB1
Gimrawiyin ..	3	—	1	1
Habbaniya ...	7	5	4	1
Halenga	7	2	5	1
Habab (?) ...	—	—	—	1
Hadendowa ..	7	—	4	2
Hamar	2	4	3	—
Hamej	2	1	1	2
Hassaniya....	1	1	2	—
Hawawir	1	2	1	—
Hawazma ...	12	10	5	1
Bani Helba ..	6	2	2	—
Hilaliya.....	2	—	1	—
Huseiniya....	1	—	—	—
Humr	4	5	3	—
Ingessana ...	1	—	—	—
Jaafara	6	—	—	—
Ja'aliyin:	105	55	38	8
Kababish	17	4	6	—
Kawahla	—	—	1	—
Kinana	2	—	—	—
Kunuz	2	—	—	—
Kinjawiyin(?)	1	—	—	1
Kunjariyin ..	1	1	—	—
Mahas	6	5	6	—
Manasir	2	1	—	—
Marafab	—	—	1	—
Maria.....	—	—	1	1
Masalit	6	7	2	1
Meseiriya	—	1	4	—
Mesellemiya ..	—	—	1	—
Nuba (undifferentiated)	51	39	20	—
Nuba-Dilling .	20	15	14	6
Gulfan .	47	41	27	3
" Sebai ..	8	6	1	1
" Mandal	9	11	3	1
" Karko..	3	3	2	0
" Fanda..	1	1	1	0
" Kujuria	1	2	0	0
" Kadero	12	9	2	—
" Kurmutte	1	2	1	0
" Tandik.	1	—	—	—

Race or Tribe	04	A2	B3	AB1
Nuba Katla ..	12	1	1	—
" Kudur .	2	1	—	—
" Nitl....	1	3	—	—
" Nyima .	39	33	14	2
" Tendia .	—	2	—	1
" Gulud .	—	—	—	2
" Kadugli.	20	10	4	2
" Miri....	19	11	8	2
" Shawabna	3	—	1	—
" Debri ..	1	2	—	—
" Abu Sinun	1	1	2	—
" Keiga .	5	8	4	1
" Talodi..	17	18	3	—
" El Liri .	3	2	1	—
" Otoro ..	1	1	2	—
" Tira ...	—	1	1	—
" Rashad.	—	2	1	—
" Tegale .	26	12	13	—
" Wali ..	1	—	—	—
" Teis....	1	1	3	—
" Shatt ..	2	4	1	—
" Tello ..	2	—	—	—
" Tagoi ..	3	—	—	—
" Koalib .	3	1	1	—
" Heiban	9	5	—	—
Rashaida	2	1	2	1
Rikabiyin ...	1	4	2	—
Rizeiqat	—	3	1	—
Rubatab	4	2	2	—
Salami (?) ...	2	1	—	—
Sara	1	2	—	—
Seleim	—	1	1	—
Shaiqiya 192		111	106	23
Shilluk	2	6	2	1
Shukriya	3	2	1	—
Somali	6	4	3	—
Sururab.....	1	1	—	—
Ta'aisha	33	24	14	6
Tungur	1	2	1	—
Yemeni	2	2	—	1
Zaghawa	4	4	1	—

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CLASSICAL REMINISCENCES IN POPULAR LITERATURE

By S. Hillelson.

Formerly of the Sudan Government.

1. *Kinayza Sitt al Shamla*

AMONGST the historical poems of the Shukrīya which I published in Vol. III of *Sudan Notes and Records* (1920), there are some verses ascribed to Al U'aysir, the *inqīb* or court poet of the Ja'alī King Nimr (died 1821). One of the quatrains reads as follows :—

الليلة النمر أصبح مطابق الحملة
وفوق بحره العريض احمى العريب ماتملى
وكت الرجال تجى تحت الدروع منغملة
داك اليوم تفزره كنيزة ست الشملة

Today the Leopard is ready for the charge ;
He forbids the wretched Arabs to drink at his broad river :
When the men go forth stifled in their coats of mail,
That is the day which Kinayza, the woman of the *shamla*, knows[1].

The allusion to Kinayza is obscure, and the tentative explanation given in the footnote on page 59 is quite unconvincing. A celebrated anthology of ancient verse, the Hamāsa of Abū Tammām (died A.D. 845) preserves seven lines by " Kanza Umm Shamla al Minqarī " whose date must be placed in the Umayyad period, since the poem ascribed to her shows her to have been a contemporary of the poet Dhū al Rumma. It is a somewhat catty satire on Dhū al Rumma's mistress, and it throws no light on the allusion in Al U'aysir's verse. It would be hazardous to rule out all connexion between Kanza Umm Shamla and Kinayza Sitt al Shamla, yet it is not easy to credit a dialect poet of the early nineteenth century with access to somewhat recondite literary material. Al U'aysir's source moreover cannot have been the Hamāsa, since Kanza's lines are quite inappropriate to his context ; on the other hand there seems to be no other reference to Kanza in Arabic literature.

[1] The text and the translation of the last line have been slightly amended.

2. *Hafūt wa lafūt.*

There is a saying ascribed to Sheikh Farah walad Taktōk, a holy man of the 17th century, whose shrine near the Sennar Dam is still a place of pilgrimage. As printed in my *Sudan Arabic Texts* (para. 115, page 160) it runs as follows :—

(النساء) فيهن هفوت فيهن لفوت ـ أنت تجى من الخلا
هى تجيك من البيوت ـ لاتديك شراباً ولا قوت ـ ولاتخلى
كلـــة تفـوت

" some (women) are flighty and meddlesome : such an one will come out of the house when you come home from the open country ; she will offer you neither food nor drink, and will leave no word unsaid."

The combination *hafūt-lafūt* is an example of the rhetorical figure called *Itbā' wa Muzāwaja*. A collection of such rhyming formulae by the grammarian Ahmad b. Faris (died A.D. 1004) was published by R. Brunnow in the memorial volume dedicated to Theodor Noldeke (*Orientalische Studien* 1906, p. 225ff). Here we read :—

وامرأة خفوت لفوت ، الخفوت الساكنة واللفوت التي
تلفت عما يكره .

" Of a woman it is said that she is *khafūt lafūt*. *Khafūt* means " quiet," and *lafūt* " one who turns away from unpleasant things."

The coincidence is striking, though the two expressions are not identical. *Hafūt* is obviously connected with هفت " *parler trop et sans raison* " (Hava), while *khafūt* belongs to خفت " *parler . . . . a voix basse.*" The translation of *lafūt* given in *Sudan Arabic Texts* should perhaps be amended in the light of the passage quoted from Ahmad b. Faris.

Is Walad Taktōk's saying derived from a literary source, did he coin it himself, or did the classical phrase survive in popular speech ?

THE ADVENTURES OF A DARFUR SLAVE.

By T. H. B. Mynors.

A FRIEND of this Journal in the United States of America has recently sent us a collection of papers which may best be described as "fragments of an autobiography." They were written by, or at the dictation of, a certain Bakir (or Bakhir) Ahmed, and consist of some 58 part-typewritten, part-manuscript sheets.

Bakir Ahmed was apparently a Kara from the southern part of Darfur born about 1865, who was captured as a child in a slave raid on his village by "bazingers" of Zubeir Pasha. Hidden from Zubeir by his captors he was smuggled by a Baggāra caravan down to the river at Dongola and thence to Saras: after changing hands various times he ended up with a Nubian of "Sacout," from whom he was purchased for fifteen pounds in gold and later freed and adopted as his son by a dragoman named Ahmed Abdel Rahim from a tourist *dahabiya* (boat).

One of the tourists, Mr. (later Sir) Reginald Beauchamp, took an interest in the boy, gave money for his education in an American Mission School, and 3 years later, in 1876, had him sent to England.

In an interlude of some 4 years, reminiscent of the manners of an earlier age, Bakir lived with the Beauchamp family as a valet, partly at Langley Park (or Hall) near Norwich, partly at a town residence in Cromwell Road, South Kensington, and partly at Yarmouth. But alas! the marriage of his patron resulted, (as marriage so often does) in changes in the household, and Bakir fell from favour. He resented his relegation to an inferior status, and as the adoptive father in Egypt was pressing for his return, Sir Reginald seems not to have been sorry of the opportunity to get rid of him.

He arrived back in Egypt at the beginning of 1881 and went to school again, partly to learn to be a telegraphist, partly to improve his Arabic, for his stay in England largely effaced what he had previously managed to acquire. But the arrival of British troops in 1882 presented opportunities of which neither Bakir nor his "father" were slow to take advantage. They quickly opened a mess for some Guards battalions quartered at Abdin Square, amongst whom Bakir recognised a regular visitor to Langley Hall, and he decided that domestic service was more lucrative than a telegraph office.

Thereafter Bakir began a second instalment of life in his native land. He first became servant to a Bimbashi Martin, who was detailed for Hick's ill-fated expedition to Kordofan, but was invalided back before it left the Nile. Bakir was then employed as an interpreter on the Gordon Relief Expedition, where he had various adventures. It appears also, although there is no account in his notes, that Bakir was on Kitchener's successful march to Khartoum in 1898.

The last, and longest, part of these notes consists of a day-to-day account of Bakir's travels in 1899-1901 as interpreter to Major Austin on his two expeditions, in the Baro River area and from Khartoum through the Lake Rudolf area to Mombasa. He is frequently mentioned, and in complimentary terms, in Austin's book (*Among Swamps and Giants in Equatorial Africa*: London, 1902). This diary, which is incomplete, contains little but the trival details of camp life and big-game shooting, and is of little interest or value.

Later he is known to have accompanied the American hunter Mr. G. Harrison on two shooting trips from Khartoum in 1905-1907. and in 1919 an American scientific expedition got in touch with him at Cairo and recorded these autobiographical fragments.

It would be interesting to know what became of him thereafter, for in the first forty years of his life he had found more adventure than falls to the lot of most Sudanese.

Three extracts from the narrative of his early years will give an idea of the style and quality.

In describing his origins at " Harrah (*sic*) south west of Sudan and next to the Province of Darfur " he says :—

(1) " The religions much still like the ancient heathens, believing in Demons, familiar spirits and worships at stones and C and C style of the early ancient Egyptians no deference they edify a large Huts for these images and kept them in by numbers and sanctuary is in centre and only the high priest enters in side and also they build up sort of Huts for convent and in it appears to them those subjects the youngmen girls used to go in to be converted and shut up for certain days and when they let out they do pinchs the other youngesters that never been went in, I have had a cousin use to pinch me with her nail fingers and my mother used run up and stops her for doing it, I could imagine the idea of it however she makes me cry all day when we are alone."

(2) " Sporting, a foot-polo nearly same as European style only this having crooked heads of bamboo sticks and ball the same kind, the playing would be between two villages and in the middle halfway starts,

by two leaders but all the rest standing in good orders, all scattered about. Thus whom could drives the ball to they home will win the sport."

(3) " Livings we generally secure our grain until next season of rain as before mentioned. The men perpetually roving about seeks for hunting gums what they could get, principally fishing they are abundant in the narrow river and small lakes, Hippo and crocodiles be sun everywhere they spears them or dig up holes and covered with grass, so may tumble in, the same to the Elephants. Curious way to fish from reeds made square and hollow at bottom a shape of bottle, having mouth open and about four feet in height by moving it about in water the fish will wabbles about inside so he, will put his hands through and pull them out."

Note.—These papers are being presented to the Gordon College Library, Khartoum.

A SHORT DESCRIPTION OF HARIG AND MAHAL METHODS OF CULTIVATION

By J. H. K. Jefferson.

Sudan Ministry of Agriculture

HARIG cultivation uses accumulations of old grass growth to rid the land of new, by burning the two off together and leaving clean land for sowing; *Mahal* cultivation uses areas where no weeds have come up at all. On the face of it there is no connection between the two, but if the origins of each are traced they are found to spring from the same root cause: they are, in fact, the by-product of a natural insurance for the survival of a species.

Let us start at the beginning. Over the grass plains of the Sudan where *harīg* and *mahal* cultivations are used, climatic and meteorological conditions vary widely. To a casual observer passing by car or train it might seem that the grass growth was uniform for miles; but a trip by animal would show that it is far from even and it would be difficult to find stretches more than two or three kilometres long containing an even quality. More often even stretches are much shorter than this.

If, in any area, the grass is examined carefully, it will be found that the number of plants in a square unit varies considerably. Where growth is strong the plants are many and where growth is poor the plants are few. The important point is that the poorer areas do not produce large numbers of poorly developed plants but relatively few. Strong growth and large numbers of plants go together; and vice versa. Over a large area, much as one would expect, there is a small amount of first quality development, and a small amount of poor or negligible development, beside the large amount of average quality. The first group provides the *harīg* for the next season, the second the *mahal* for the current one.

It is this fact of what might be called "differential germination" that accounts for the existence of *harīg* and *mahal* areas. The characteristic is possessed to a greater or less degree by all wild plants but is carefully bred out of all domestic ones. It is a natural mechanism for ensuring the survival of species by arranging for the seeds produced

in any one season to germinate over a subsequent period of years. There is a further mechanism which is particularly apposite to the germination of *harīg* grasses, and that is that the seeds themselves appear to be able to select in advance a favourable season for growth, only germinating if conditions will be right. This sounds impossible but it certainly appears to an observer that there is some factor in the summer which conditions grass seeds as to their germinability for the future growing season. In some seasons *anīs*, the main *harīg* grass, will go on germinating right up to the last drop of moisture ; in others no amount of rain will make it germinate. In this way the chances of survival of the species of the wild grass are enhanced by nature arranging for their seeds, stored in the ground, to come forth only in years when they are likely to grow well and produce a good crop of seeds.

So much for theory. Now for some practical details.

Since the two methods of cultivation are the product of a sort of natural insurance device, so they only occur where this device is rendered necessary ; that is in areas of erratic rainfall—where the annual fall is somewhere near the average (say to within 50% of it one way or the other) not where the rainfall varies from nothing to a low maximum. In the areas in question the rains are erratic mostly with reference to the wild grasses ; the cultivated plants are better able to withstand effects of bad distribution of showers within a season.

Expressed differently there is a belt suitable for *harīg* cultivation across the country, whose northernmost limit is about the 450 mm. isohyet and whose southernmost one about the 650 mm. isohyet. There are *harīgs* quite a long way south of this but they are not on the large scale of those further north and they are really only *harīg*-assisted village plots[1]. The further south you go the less effective is the *harīg*, since although a large number of weed seeds come up in one season they do not all come up by the time the *harīg* is ready to burn, and if a man waits too long he misses the best growing time for his crops. This problem presents itself, to a greater or lesser extent, wherever *harīg* is practised. The best *harīg* years are those where *mahal* or " near-*mahal* " occurs under a good matt of old grass so that secondary growth after burning is small. On the other hand, where—due to conditioning of seeds during prior months—grass keeps on coming up thickly after burning, cultivators sometimes abandon the *harīg* altogether. It is a favourite practise of lazy sections of tribes to leave the *harīg* for some time after burning

[1] *Harig* using *Anis* grass is most successfully practised by the Dinka south of the latitude of Melut and by the Shilluk south of the latitude of Kodok.—*Ed.*

to see what will happen. If they see a new green sheen appearing, they leave the whole thing. This is a highly pernicious practice for two reasons. Firstly these people usually wait so long before reaching a decision that it is then too late for a more energetic person to put in a crop; secondly burning off an *harīg* that has the signs of subsequent growth in it should be avoided at all costs if it is not to be sown, for if left it will make a fine contribution to another year's *harīg*.

As to the kinds of grass which are used for *harīg* cultivation, the main one, as stated, is known as *Anīs* and is specially suitable for two reasons: firstly, because after it is ripe and dead it breaks in the wind about a third of or half the way up the stem so that a stretch of it looks like arrested waves of the sea; this interlocking of bentdown stems enables the fire to be carried well over the ground: secondly, the dead material of *Anīs* grass appears to have a lower flash-point than other grasses and when alight it burns persistently. This is unlike the second *harīg* grass, *Nāāl*; this grass takes a good deal of heat to set it on fire and then it goes off in a flash which has little time to extend the fire to adjacent plants. A further point in favour of *Anīs* and against *Nāāl* is that it does not occur in tufts, which are very unfavourable for fire-carrying since they place the individual brands some way apart.

These two grasses occur in the main *harīg* belt in about the same proportions. I have often tried to get local people to express an opinion as to whether one is increasing at the expense of the other, but without success, so it is probable that there is no significant change. A third grass which occurs in the main *harīg* belt is called *Dumbelab*. This is a short, fine-stemmed grass which makes very good *harīg*, but there is not much of it. It nearly always grows in places where there has been a forest, usually of *kitr* bush, and it is itself usually replaced by either *Anīs* or *Nāāl*. A fourth grass good for *harīg* is known as *Anzora*. This is a very tall grass and only occurs in the southern zones. It has the disadvantage, explained above, of producing heavy aftergrowths after burning. An advantage which derives from the same source and which compensates for this is the fact that it can be relied upon to grow regularly year after year in the same area. Villagers do not have to go miles to reach the cultivatable areas; they occur, as it were, on their doorsteps.

There is another point of "*harīg* technique" which is worth mentioning. It is unusual for a single year's growth to produce a good *harīg*. In order to deal with the damp green shoots of new weeds it is best to have a layer of dead material on the ground which has come from two or even three seasons before. Then the newer dead grass above

catches the wind and the bottom layer acts as a sort of carrier fuse. After dead grass has been rotted by the sun and wind for two years it becomes very fuse-like and holds a fire tenaciously.

The technique of *harīg* cultivation limits and defines the areas in which it can be carried out, apart from the restriction imposed by rainfall. Its areas must be remote from habitation and reasonably free from the passage of cattle through them on their way north or south during their annual migrations; or the accumulations of burnable material will be destroyed by accidental or wilfully started fires, and the new material may be so trampled down as to be useless. Thus *harīg* areas are without permanent water supplies and cultivators must be very self-reliant when operating in them; except after the rains are well started, when there is usually a certain amount of surface water about. But for the establishment of the crop and for its harvesting water supply is a difficult matter.

The main *harīg* areas of the Sudan are five. Starting from the west these are: the Dar el Ahamda area south-west of Kosti, the Jebel Moya-Jebel Dali area just west of Sennar, the Dinder area between Es Suki and the Rahad river, the southern Butana area south-west of Gedaref, and the Gaboba area north-east of Gedaref. The main grass in all of these is *Anīs*. As to the gross area, it is difficult to give anything but an approximate estimate; I should say about 7,500 square miles or 4,500,000 feddans. In a very good year about 2% of this—or 90,000 feddans—would be cultivated; a yield of one third of a ton or slightly less might accrue, giving say 30,000 tons of grain. It is easy to see that *harīg* is an important contributor to the Sudan's larder.

Harīg cultivation has proved a good subject for artificial encouragement. This has been given increasingly in recent years by the Ministry of Agriculture through fireline protection. The work started in a small way, early in the war, by the protection of areas of good growth, immediately after the rains and before the southward migration of the Arabs made fires numerous. It has now developed into an elaborate annual programme whose object is a continuous protection of defined zones in order to ensure accumulations of grass for the future, rather than the earlier hand-to-mouth practice of protecting only what good grass occurred each season. As explained above, good *harīg* must have more than one season's growth to burn, and therefore any successful programme for its encouragement must be based upon the continuous protection of fixed zones and not upon the original experimental small-scale method of local annual protection. If this latter method were followed there would never be more than a small amount of good *harīg*

available, for the odds against the accumulation of grass over two years —if unprotected in one of them—are very great.

It would not be too much to hope that, given staff and machinery, the proportion of *harīg* available annually from the total area might be raised to 3% in an average year, as opposed to only 2% in a very good year as at present. This would mean some 135,000 feddans annually, or say 40,000 tons of grain, as against about 15,000 tons as an annual average to-day. In order to attain this increase some 2000 miles of fireline would be needed annually which would cost, using machinery, about L.E. 5 per mile, or L.E. 10,000. It is probable that the cost could be substantially reduced, but let this figure stand to be on the safe side. Additionally some L.E. 5000 would be needed to maintain fire and police parties to cope with accidental or wilful fires within the protected blocks, giving a total of L.E. 15,000, or 37 P.T. per ton of grain produced, say 40 P.T.

This development of *harīg* cultivation might go closely with the development of a new village system as previously outlined.[2] Eventually a good deal of the land occupied by *harīgs* might have to be taken for permanent settlement, but for at least ten years the new villagers would find that, in addition to their village plots, there would be ample *harīg* land available. One of the fortunate things about *harīg* cultivation is that it can be practised by persons already working normal village lands, since the operations just fall into the slack periods of village cultivation. If a man sows and does the first cleaning of a village plot in July and early August, he can then go off to burn, sow, and if necessary clean, his *harīg*, return to the village to clean his plot there and go back to the *harīg* if he wishes. Harvest operations dovetail in the same way.

Note.

The Director of Agriculture comments on the above article as follows :—

> "The hazards of rainfall here so well described are in themselves reasons for caution in seeking to substitute shifting agriculture by settled agriculture in the hazardous isohyets."

[2] See *Sudan Notes and Records*, Vol. XXX (1949) Part I.—*Ed.*

OBITUARY

W. F. Hume.

We regret to record the death of William Fraser Hume on February 23rd. 1949. He was born on October 1st. 1867.

Dr. Hume became in 1897 one of the first members of the Geological Survey of Egypt, becoming Director in 1909.

Hume's work in the Sudan is included in Volume II of his *Geology of Egypt* (part I 1934, part II, 1935).

The staff of Geological Survey of Egypt was engaged in measuring discharges of the Nile in the Sudan between 1901 and 1907, and Hume spent five field seasons in the Sudan. From the specimens collected and registered in the Geological Museums, Cairo, it appears that the second cataract was the subject of study in the 1900-1901 season, work being extended to the reach between Dongola and Halfa in the following season, with a visit to Khartoum and Dueim.

In the 1902-3 season the Sabaloka cataract was visited; further work was done on the Halfa-Dongola reach in a later season, the fourth cataract (and Sabaloka) being examined in the 1906/7 season.

Dr. Hume's valuable indirect contributions to Sudan geology are contained in his studies of the pre-Cambrian rocks of the Eastern Desert of Egypt (*Geology of Egypt* II) and of the minerals of economic value (*ib.* part 3, 1937). In these publications, for the preparation of which his services were retained by the Egyptian Government as "Technical Counsellor" after his retirement from the Directorship of the Geological Survey in 1927, considerable progress was made in the classification of the pre-Cambrian metamorphic and igneous rocks and the related ore deposits. These last publications contain a great deal of scattered unpublished data, or information published but difficult of access because the original publications are out of print or not generally easily available, as well as interpretation and comment, They form a truer memorial of the man and the geologist than any notice.

BOOK REVIEWS.

BANTU WORD DIVISION. By M. Guthrie, Ph.D., M. Sc. Oxford University Press (for International African Institute), 1948. pp.32. 3/-.

" What's in a word ? " Apparently a very great deal if one can first find out what a word is, and this is a question that has been the subject of protracted controversy amongst linguists ever since African languages first came to be written down. The present diversity in the method of word division was largely caused by the diversity of linguistic background of the European investigators responsible for reducing them to writing. For instance, because originally in English " We are doing " was written in three words, the Bantu equivalent was divided into three words, whereas French investigators having two words in mind for the same idea divided into two words only. More recently the problem has fined down to two schools of thought known as the conjunctivist and the disjunctivist. The two points of view are irreconcilable, and an impasse, not unaccompanied with pointless argument and sometimes acrimony, has been reached.

Dr. Guthrie brings a fresh breeze to the whole problem and tackles it from a new angle. As he says " The real problem then is : Where ought the sentence to be divided ? " This is quite different from the usual question : To join or not to join ? He claims that most of the difficulties can be resolved in such a way as to admit of one solution only. This thesis he establishes fundamentally with great success since he brings an objective attitude to bear on the problem.

He opens with a critical review of the principles which may be invoked in a discussion on the division of the sentence. Isolation is one of the most obvious ways to discover the breaks in a sentence, an attempt to find out what parts of the sentence can stand alone. Interpolation or omission is another method, consisting in experimentally inserting or removing segments within a sentence. Substitution of segments known to be distinct pieces is sometimes useful, and interruption, or occasions when ellipsis occurs, are valuable particularly in cases of proverbs or other fixed formulae. Transposition of segments of the sentence can give useful indications of the place of the breaks. But

Dr. Guthrie rightly points out that most of these principles are concerned with what may be called " grammar of movement " and it is the " grammar of relationships " which is one of the most important considerations when seeking a solution to the problem of sentence division.

The author then proceeds to a detailed study of the problem as it affects Bemba, taking first of all Nominal Segments and going on to simple and complex Verbal Segments. The third part of the monograph concerns the phonetic behaviour of the " pieces " into which the sentence has now been divided. The section is divided into four parts dealing with (1) vowel length, (2) consecutive high-tones, (3) indeterminate tones, (4) tone patterns ; and shows how such criteria can be used to test assumptions made on other grounds.

Dr. Guthrie may fairly be held to have established his claim that it is possible to apply a scientific method to this particular linguistic problem.

There is however one great practical problem which remains to be solved, and that is the division of words to be used in what the author describes as " everyday " spelling. His establishment of " compound pieces " requires the use of tildes, dots and hyphens and he notes in a footnote that in an " everyday " spelling it might easily prove to be desirable to reduce the number of these separating signs. A great deal of further research is needed on the problem of the most satisfactory system of word division for printed books to be used by native speakers of any language. Experience in the southern Sudan would lend to show that a system based solely on phonetic and/or syntagmatic considerations may not be the most satisfactory from the point of view of ease and speed of learning and subsequently of reading a language. The length of a word, connected as it is with eye-span and eye-movement, needs to be considered on other grounds besides those set out in the monograph. The physiological processes concerned in reading seem not to have been given sufficient weight as yet.

Dr. Guthrie says in his introduction " What we want to know is where..... the writer will lift his pen and the printer will put a space." This is exactly the problem which confronts everyone who is concerned with deciding how languages, without an established literary convention, are to be written ; but although Dr. Guthrie methodically establishes his theory of conceptual breaks, whether these are the correct breaks for writing and printing must needs await further research which it is hoped he and the staff of the School of Oriental and African Studies will undertake at an early date.

G. JANSON SMITH.

DISTRIBUTION OF THE NILOTIC AND NILO-HAMITIC LANGUAGES OF AFRICA. By M. A. Bryan, M.A. Linguistic Analyses by A. N. Tucker, M.A., Ph.D. Oxford University Press (for International African Institute), 1948. pp. 60. 7/6.

This study is one of a series of publications issued in connexion with the Handbook of African Languages which the International African Institute is preparing with the aid of a grant made by the Secretary of State under the Colonial Development and Welfare Acts on the recommendation of the Colonial Social Science Research Council.

The Handbook is to appear at its first level as a general survey of existing information in four volumes covering Bantu Africa, North Africa, West Africa and North-east Africa.

The basic unit used in classification is the Language or Dialect Cluster. These basic units, where information permits, are classified under groups *e.g.* the Lwo group of Nilotic Languages or the Nandi group of Nilo-Hamitic languages. The relationships between languages and dialects within the group are briefly described and the authorities for statements on such relationships are quoted.

For each language data are given on locality, number of speakers, use for educational and religious purposes, and the extent of vernacular literature. The linguistic material is set out in phonetic script with tone marks, though reference is made to current standard orthographies where these exist.

This pamphlet reveals the paucity of accurate linguistic information that exists in the languages listed, and Dr. Tucker in his Preface puts out a plea for criticism and correction, before the North-east African volume is published in about a year's time. Another gap which is revealed is the lack of sufficient literature in the languages which have been chosen for educational purposes. These are however encouraging signs that active steps are now being taken both by Missions and Governments to remedy this state of affairs and the setting up of Language and Publications Bureaux both in the southern Sudan and in Nairobi is noted.

The linguistic analyses are short but comprehensive of the main points to be noted. The map printed in red and black and showing the location of the language groups and main languages, is a valuable asset, as is the 10 page bibliography. This is a valuable pamphlet for anyone interested in any of the languages of the southern Sudan. It is to be hoped that it will stimulate further research into them and also the production of more and more literature in the vernaculars.

G. JANSON SMITH.

REPORT ON THE WATER RESOURCES OF THE BECHUANALAND PROTECTORATE, NORTHERN RHODESIA, THE NYASALAND PROTECTORATE, TANGANYIKA TERRITORY, KENYA AND THE UGANDA PROTECTORATE. Colonial Research Publications No. 2, 1948. 85 pp. 10/6 d.

THE WATER RESOURCES OF CENTRAL AFRICA. Geographical Journal Vol. CXIII, pp. 222-234, 1948.

Both by Professor F. Debenham.

These two publications place on record a review of what has so far been attempted and what has been achieved in the way of study and experimental work on the one of the most important problems of central Africa—that of water supply.

In *The Water Resources of Central Africa* emphasis is laid on the need for collection of data—rainfall, (particularly the variability of rains), run-off, evaporation, and ecology. Professor Debenham describes some underground dams, and remarks that " One cannot travel through such countries for long without coming to the conclusion that quite the best way to conserve water is to keep it underground." A discussion of the swamp area of Lake Bangweulu introduces the idea of drainage. Both these principles are of importance in the Sudan.

The Colonial Research Report gives a fuller treatment of the territories named in the title. The introductory statement in Part I (pp. 11-30) is applicable to the Sudan almost in its entirely, and should be studied by all concerned with water. The statement includes a brief discussion on the organisation of water development as well as scientific and human aspects.

The treatment of swamps is dealt with in an appendix (pp. 79-81) and a second appendix covers " sand rivers " (pp. 82-85).

G. ANDREW.

AGRICULTURE IN THE SUDAN. By Numerous Authors, edited by J. D. Tothill, C.M.G., D.Sc. Oxford University Press, 1948. pp. 974. 42/-

This notable work goes a long way to remedy the deficiency in descriptive literature about the Sudan—the adjective should be emphasized, for this sets out to be no more than a " Handbook of Agriculture as practised in the Anglo-Egyptian Sudan," written as far as possible for the general reader : the future development of agriculture still largely lacks published studies.

Adequately to review so full a work would require not one but a series of reviewers, as it is a mine of information on a wide range of subjects. It falls into three parts, *viz.* General Chapters (14) on the physical and administrative background ; Chapters (10) on Agricultural Crops, Methods etc. ; and Chapters describing the agriculture of each province separately.

The bulk (and therefore the price) of the volume is somewhat formidable and it is possible to argue that the first section could with advantage have been pruned, *e.g.* the material on history, education, transport, taxation etc. Where so much is described it is strange that the general administrative organisation—and in particular the Agriculture Department—is hardly mentioned. It is also very much to be regretted that apart from very full treatment of research problems, the great Gezira Scheme—an experiment of international interest—receives a paltry 30 pages out of the 970 of the whole work. Whilst the problems of the Gezira may be said to be social and administrative as much as strictly agricultural, this is equally true of every part of the country where it is desired to stimulate production, but little treatment of this aspect is to be found here. Some unevenness of treatment, errors or omissions may not be surprising in a pioneer work of this kind.

The 400 illustrations add greatly to the value of the work, though it is to be wished that some were a little larger and clearer. Problems of transliteration of Arabic have on the whole been successfully surmounted, but with some exceptions *e.g.* in Chapter IX.

T. H. B. MYNORS.

ECONOMICS IN THE MIDDLE EAST

STATE & ECONOMICS IN THE MIDDLE EAST : A SOCIETY IN TRANSITION. By A. Bonne. Routledge (International Library of Sociology and Social Reconstruction). pp. 427. 30/-.

LAND AND POVERTY IN THE MIDDLE EAST. By D. Warriner. Oxford University Press (for R.I.I.A.). pp. 140. 7/6.

WAR ECONOMICS OF PRIMARY PRODUCING COUNTRIES. By A. R. Prest. Cambridge University Press. pp. 308. 21/-.

EGYPT : AN ECONOMIC AND SOCIAL ANALYSIS. By C. Issawi. Oxford University Press. pp. 219. 15/-.

By comparison with the dearth of books before the late War, the importance suddenly assumed by the economic resources of the Middle East countries for their own support and that of the Allied armies and

for the development of mineral wealth thereafter has led to intensive study and to a steady flow of publications on economic, agricultural and social matters. The Sudan finds little place in these studies as a rule, for which the lack of published material is largely to blame; but there is often much of direct relevance to be observed in other countries and in any case the future relations of the Sudan with them require that Sudan opinion should be well informed.

Of the four books listed above, that of Bonne may be quickly dealt with. Despite the enormous potential interest of the subject, it is stilted and almost unreadable, though valuable as a collection of statistics and references. Miss Warriner's study, on the other hand, though brief, is eminently clear: she surveys the situation regarding Land and Population in each territory separately and then the question of land utilisation in general. She rightly stresses the fact that recognition of individual title in land by no means results in the establishment of an independent peasant class, and that it is the impossibility of their investing capital in agriculture on an individual scale which necessitates some form of organisation if the peasants' status is to be raised. Her account of landlordism should be a warning to the Sudan at a time when hereditary leaders are tending to profit by their slowly waning prestige to acquire economic ascendancy in place of other forms of authority.

In this connection one may quote the opinion of an Indian economist that Cooperation is inapplicable, as normally conceived, to economically undeveloped and backward countries—largely because those who tend to become members of cooperatives are precisely those who have nothing to contribute but who hope to borrow as much as possible, whilst those who are well-to-do stay outside the movement. The function required is that of a bank. His (rather uneven) study may be recommended as a corrective to undue optimism regarding Cooperation as a panacea for peasant poverty. (*The Future of the Cooperative Movement in India*, by A. I. Qureshi. O.U.P. 1947).

Mr. Prest's unusual study deals with the Sudan and other Middle East countries, also India, Nigeria and Trinidad: he assesses the physical and financial changes occurring in each during the War years 1939-1944, the degree of inflation and the attempted control, and he ends with a brief critique of each Government's policy. His chapter on the Sudan is based on somewhat limited material and he seems to attribute greater coherence and equity than was the case to the schemes of rural distribution of controlled commodities, whilst he describes the Omdurman town scheme without mentioning the peculiar advantages which it enjoyed.

He praises the measures whereby the inflated prices of exports were deflected to the Price Stabilisation Reserve so that it was possible to declare the *official* retail price index at only 70% above pre-war levels; but he notes the tardy introduction of controls and the absence of any comprehensive fiscal policy. His study stops just too soon for the sharp rise in prices that followed, and the full story of these War years could probably only be written by someone with inside knowledge.

A first exception that might be made to Mr. Issawi's welcome book. which should be widely read in the Sudan as the best available recent account of the internal Egyptian situation, is that he has tried to cover so enormous a field in only 200 pages that it can be but a superficial study. He deals with the historical background, industry, commerce and agriculture, finance, politics, education, literature and more. Apart from its intrinsic interest as a study of Egypt, it has many points of interest and importance for the Sudan. He describes admirably the many difficulties in the way of establishing industries, many of which are even greater in the Sudan, the shortage of artisans compared with a large volume of "white collar" unemployment, the so far socially unsatisfactory results of education and so on. His analysis of the political impact of foreign rule is acute, though he does not pursue further a most suggestive remark about the decline in the quality of British official employed. His final suggestion of emigration—including emigration to the Sudan—as the only real solution for Egypt's population problem is somewhat unrealistic and is not likely to be warmly received here.

T. H. B. MYNORS.

GORDON, GESSI E LA RICONQUISTA DEL SUDAN. By Carlo Zaghi. Firenze. Università degli Studi di Firenze, Centro di Studi Coloniali, xxxiii, 1947. pp. 639.

War has been unkind to the memory of Romolo Gessi Pasha, governor of the Bahr el Ghazal in 1879-80 and one of C. G. Gordon Pasha's chief officers during his first governorship-general. Part of Gessi's papers was lost during the Austro-Hungarian occupation of the country north of the Piave in the first world war. The present book, by the author of a sympathetic life of Gessi published in 1939, was the first of three studies on which Signor Zaghi was working when Italy entered the second world war. The second study was to have been devoted to Gordon's lesser known Italian collaborators, the third to the Milanese soldier of fortune, G. Cuzzi, who was British consular agent at Berber in 1884. By 1943 all three manuscripts were ready for the

press when the last two were destroyed in the Allied air bombardment of the North Italian cities. The printing of the surviving study was next delayed by the imprisonment of the author by Mussolini's republican government. Finally, with the help of official and private friends, the book at last came out in 1947. Signor Zaghi brushes aside these years of anguish in the briefest of prefaces ; there is no resentment, no self-pity.

The present study carries the story of Gessi and his fellow-Italians into the early years of the Condominium when the Italian Government sent Carlo Rossetti on a mission to the Sudan to inquire into the effect of the Condominium rule on the Italian community. Rossetti's findings were not reassuring for, after the special position held by Italians in the Sudan during the latter part of the *Turkīya* both in commerce (since Sa'īd Pasha's time) and in administration (since Gordon's first term of office), Italy looked with misgiving on the diminution of Italian influence under the new régime of 1899.

Most of the book is taken up with reproduced documents from various sources, none particularly startling to the worker in Sudanese history. Many of them deal with Gessi's fight against the slave trade and are cited in evident apology of Gessi's violent methods in it srepression. All the fuss about the slave trade in the Sudan seems at first sight so trivial today when whole peoples are enslaved by modern god-states. But in the eighteen-seventies men in Europe still held firmly to a belief in personal liberty ; for them slavery was not so much an obsolescent social institution as a sin.

Relatively full as is the documentation from the European sources, Zaghi's book totally lacks evidence that the author consulted the Egyptian Government archives except through the translated selections of Douin's *Histoire*. He has made no attempt to represent the point of view, for instance, of Muhammed Ra'ūf Pasha, Gessi's chief in 1880, who not only objected to Gessi's arbitrary acts against the slave traders but was naturally more interested in administration in general than in Gessi's emphasis on the slave trade in particular. Zaghi tars himself with the same brush that has disfigured so many British and Egyptian writers on the Sudan who have used history for praising their friends and damning their enemies. It is one-sided to laugh at Egyptian historians for uncritically loading the case against Gordon and Gessi so long as European authors ignore the Egyptian sources.

The book thus suffers from a partial treatment of the theme. Arabic words are handled in such a way as to suggest the author's lack of knowledge in the language which mattered most in Egyptian official correspondence. Incidentally Gessi, from his long Ottoman experience,

knew at any rate colloquial Turkish as his own transcriptions of Arabic words show ; he pronounced them as a Turk would, as when he writes *Fuat* for Fū'ād and *bash kehatip* for bāsh kātib. Errors of transcription abound of which the author is ignorant. The work abounds also in misspellings of the English language, but that is a traditional privilege of Italian scholarship abetted by our incredible spelling habits. One or two of his biographies of minor Italians in the Sudan would have been improved had Zaghi been able to drop in for an evening at the Italian club in Khartoum in the days when stories about Pietrino Agati and the old hands, the *pionieri*, were still warm with the breath of life.

God knows how many millions of words have been spoken and written about Gordon and his times, how weary beyond endurance the tale of that dead controversy. Yet, for all that, the balanced history of Gordon and Gessi as administrators of the Khedivial Government has still to be written. This book, though it has no pretensions, fulfils its proper role in presenting important material for filling in the Italian background to the story.

R. L. HILL.

Museums in Khartoum

Khartoum Antiquities Museum

This contains objects from the earliest times to the Fung period. It lies on the river front to the west of the Gordon College. Two piastres is charged for admission. Troops in uniform are admitted free. Open every day from 9 a.m. to 1 p.m. and from 3 p.m. to 6 p.m.

Natural History Museum

This is an annexe to the above and contains mainly ornithological exhibits.

Khalifa's House Museum, Omdurman

This contains objects from the Turkia and Mahdia periods. It is close to the Mahdi's tomb. Entrance is the same as for the Antiquities Museum.

The Commissioner for Archaeology (Mr. P. L. Shinnie), whose office is at the Khartoum Museum (Phone **2809**), welcomes enquiries about any of the above museums (except Natural History). Enquiries about the Natural History Museum should be addressed to The Curator, Natural History Museum (Mr. J. W. Cowland), Research Division, Agriculture and Forests, Wad Medani, or to his representative in Khartoum, The Entomologist, Khartoum North.

There are also small museums of Antiquities at Merowe, Suakin, Wadi Halfa and Port Sudan.

Geological Museum.

On the river front between the Public Works Dept. and the Sudan Club.

Open daily.

Graphic Museum (Medical and Public Health).

Adjacent to the Civil Hospital facing the railway station.

Open daily.

Zoological Gardens.

On the river front near the Grand Hotel.

Open daily.