TANGANYIKA NOTES AND RECORDS

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Contents

Obituary

Frank Oates, Esquire, O.B.E.

FRANK OATES was born on the 10th February 1890, educated at Epsom College in Surrey between the years 1904 and 1907. From 1908 to 1912 he attended classes at the Battersea Polytechnic whence he graduated B.Sc. at London University in Chemistry, Physics and Botany. Just before the great war of 1914-18 Oates entered the Royal School of Mines, Imperial College of Science and Technology at South Kensington, but the course in Mining Geology was interrupted by military service. The great war saw him first as a private in the Grenadier Guards and soon afterwards as a commissioned officer in the Royal Engineers. His particular branch of the Royal Engineers specialized in trench (smoke and gas) mortar and liquid fire warfare, in the 5th Battalion of the Special Brigade. The strain of the training in the Grenadier Guards and the life in the trenches during 1915-17 compelled him to concentrate on work in England. For the most of 1918 he was Experimental Officer at the Wembley Experimental Station, Chemical Warfare Department, Ministry of Munitions, chiefly engaged on research in toxic gases. For this work he was awarded the M.B.E., Military Division. On demobilization he returned to the Royal School of Mines to complete his course in Mining Geology, gaining the Diploma (1st Class) in 1921. Of the various learned societies to which he was elected at that time, mention may be made of his election as Associate to the Institute of Chemistry and the Institution of Mining and Metallurgy. His first appointment in the Colonial Service occurred soon afterwards as Personal Assistant to the Director of Geological Survey, Gold Coast Colony, and as Geologist in 1924. Owing to ill health he was unable to continue the strenuous life of a geologist in the field and was appointed in 1929 Chemist and Petrologist to the Geological Survey in Tanganyika, East Africa. After various periods of acting as Chief Geologist and one period as Chief Inspector of Mines, Lands and Mines Department, he was appointed as Chief Geologist in 1943, which position he held at the time of his death. He was awarded the O.B.E. in 1945.

In addition to being a skilled and keen technician in the experimental branch of his profession, Oates had a well garnished, lucid and scholarly mind. On every work he undertook he left his mark of understanding and thoroughness. In the Geological Survey he made his impression principally as a petrologist and experimentalist in the laboratory and as editor of many of the

various publications of the Survey. It is a fact that from 1930 onwards every publication of the Geological Survey went through his hands and was edited by him. In several of the Bulletins and Short Papers published by the Geological Survey he was joint author, especially those connected with the Lupa and Saragura Goldfields, for which he contributed the petrological sections. His outstanding contributions were *Bulletin No. 4*, "Limestone Deposits of Tanganyika", and the Revised Edition of the "Mineral Resources of Tanganyika" (*Bulletin No. 16*).

It was due to Oates's inspiration and drive that the production of a large number of utility and substitute articles was embarked upon during the war. Some eighty-five thousand abrasive articles were fabricated in the laboratories and factory of the Geological Division at Dodoma during the years 1943-45. These articles have and are being used on the rubber and sisal estates of East Africa, where they have contributed in no small measure to the increased production of rubber and sisal.

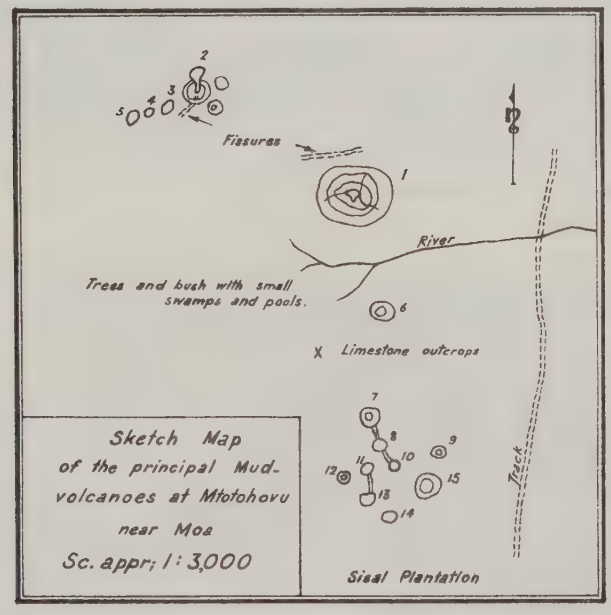
Oates was a likeable man, but his deafness deterred him from associating a great deal with his fellows; he was charged with restless energy and took a lively interest in the affairs of the day. Beyond the immediate boundaries of his profession of chemist and geologist he took a keen interest in local ornithology in which he was no mean amateur.

It was in the latter years that his cardiac weakness became more apparent, and there is no doubt that he taxed his strength beyond its capacity and this, coupled with an intense devotion to duty, partly inspired by the needs of the war, so severely weakened him that he died on 10th June 1945, a few days after his return to England on retirement. Oates may be considered as a war casualty, equal to any man in the Services who dies at his post.—G.M.S.

The Mudvolcanoes of Moa, near Tanga

By J. J. Richard

AT THE end of January 1944, Mr. C. Gillman of Dar es Salaam directed my attention to the mudvolcanoes of Moa. This resulted in two short visits being made to these interesting formations, the first on the 12th of February, the second on the 4th of September 1944. The occurrence of mudvolcanoes in East Africa is not a new feature. Obst, 1911, found a mudvolcano near Lake Eyassi, while Gregory, 1921, page 178, mentions a group of mudvolcanoes on the eastern shore of Lake Magadi.



The miniature volcanoes of Moa are situated roughly seven miles north of the locality of that name on Lieutenant-Colonel the Hon'ble M. T. Boscawen's Mtotohovu sisal estate. Their existence was known by the local population under the name of *Maji ya chemchemi*. A native track passes nearby and the volcanoes are within easy reach of the sisal factory by car through plantation roads (about four miles). By some of the coast people, the phenomenon is thought to be related with the doings of evil spirits: *Zimewekwa*

na shetani. Bush people, *Watu washenzi*, according to my Swahili guide, come there to pray for health and to bring offerings (Fig. 1) near one of the mounds. Animal life is not absent from the area; elephant spoor was visible near the volcanoes and during the afternoon of my stay on the 12th of February 1944 a family of five wild pigs were seen bathing in one of the pools nearby.

The volcanoes consist of a group of over fifteen small conical mounds showing signs of past and present activity in an area covering approximately 250 yards by 165 yards (*vide* sketch map). This group lies in a depression at the north-east foot of the gently sloping sisal plantation and is approximately seventy-five to one hundred feet above sea-level.* In the lowest parts some shallow pools are seen where water collects during the rains. Several outcrops of pitted limestone are apparent, while the soil consists of reddish grits and silts derived from the gneissic formation as found in the eastern Usambaras. The pools, in the wet weather, feed a small stream flowing eastwards in the direction of one of the bays, about one and three-quarters of a mile distant.

The vegetation consists of bush with some tall *Mwalambe* trees (*Terminalia prunoides*) and *Mkoche* palms (*Hyphaene coriacea*), several grass species and a low shrub (*Pluchea sordida*),† common along sea-shores in salty soils. The latter was seen only in the immediate vicinity of the mudvolcanoes. Gasteropoda shells (*Terebralia palustris*), an estuarine mollusc, lay scattered around, showing the vicinity of the sea-shore.

No. 1 mound, through its size the most important though inactive at the time of my visit in February 1944, consisted of a round hillock with a circumference of about one hundred and thirty yards and was five and a half yards high (Figs. 2 and 3). Its broad, flattened top was showing three small depressions filled with water (Figs. 4 and 5), marking the spot where former mudstreams had flown out. Some water trickled out of one of these depressions. The hill itself consisted mainly of hardened mud, of gritty yellow silts, sands and fine clays with white crystalline gravels and a few rounded quartz pebbles of about nut size. Some fairly coarse white sandstone fragments lay about as well as a whitish conglomerate made of a mixture of lime and quartz particles, with some feldspar, red and pink garnets, magnetite and hornblende. Dark brown nodules of iron hydroxide had also been brought to the surface by the mudflows.

When walking near the craterlets, on top of the hill, the ground was shaking and quivering unsafely like jelly and a few small air bubbles escaped from the water. This had a slightly salty taste and showed alkaline reaction

*To the south-east, in the sisal plantation nearby, there exist another fifty to one hundred hillocks, mostly under fifteen feet high, whose origin was not ascertained. (These are termite mounds.—EDITOR, *T.N.R.*)

†The two former were kindly determined by Peter R. O. Bally, Botanist of the Coryndon Memorial Museum, Nairobi, the latter by P. J. Greenway, Systematic Botanist, East African Agricultural Research Institute, Amani.

Fig. 1.—Offering place near Mound No. 1

Fig. 2.—Mound No. 1 from the East, with *Plectus Sordidus* in foreground, dead palm on left, *Mwalambe* to the right

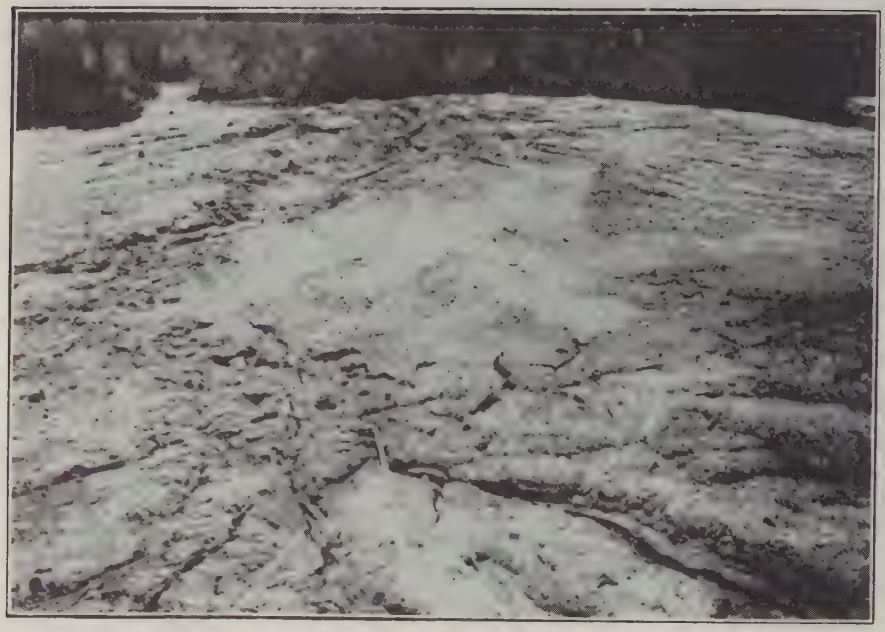


Fig. 3.—Mound No. 1

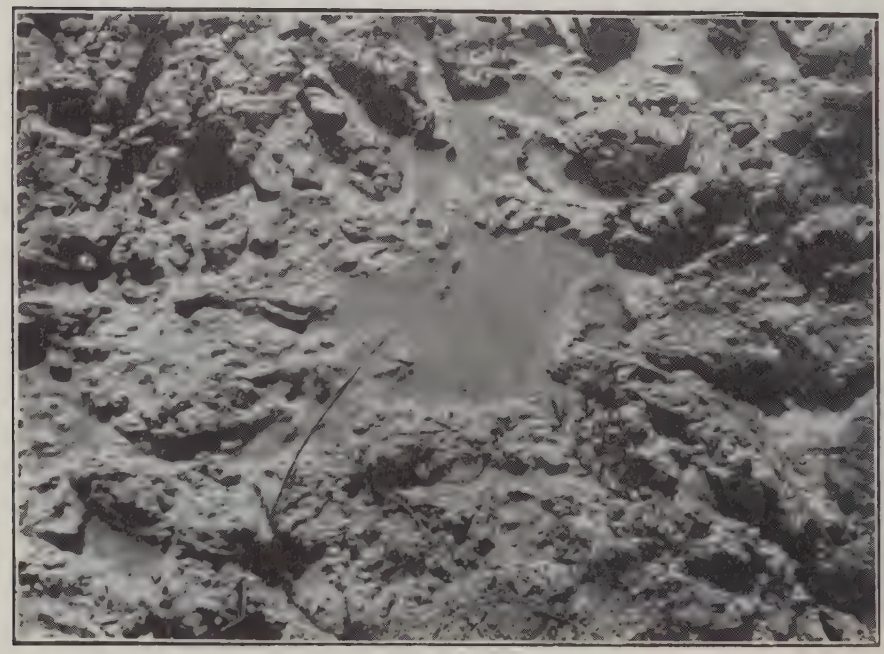


Fig. 4.—Top part of Mound No. 1

Fig. 5. Top part of Mound No 1

Fig. 6. Mound No. 2. The mudflow at its point of issue

Fig. 7.—Mound No. 2 from the North

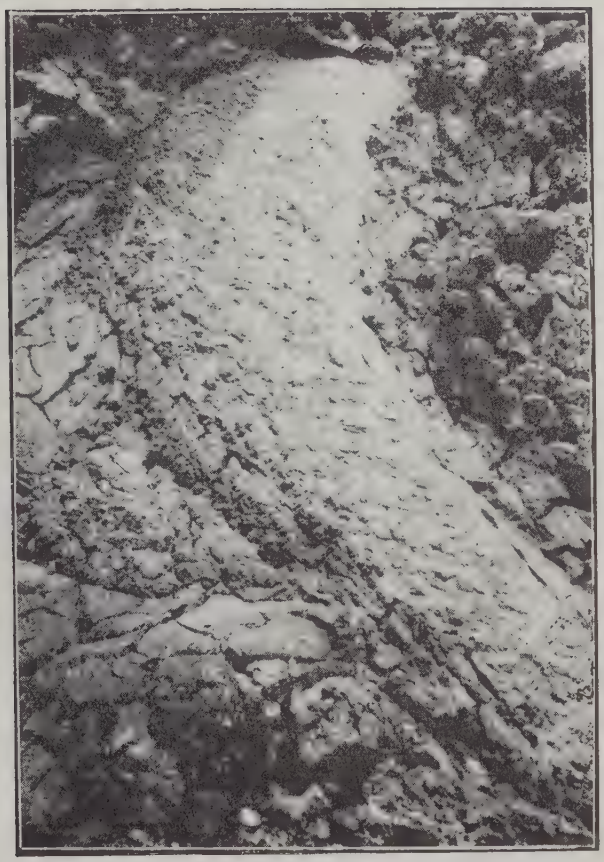


Fig. 8.—The mud flow from Mound No. 2

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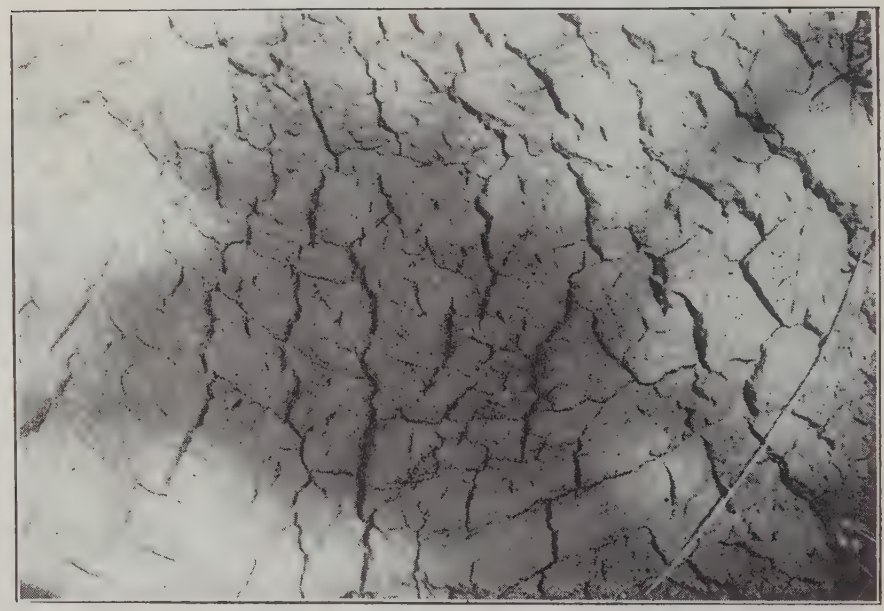

Fig. 9.—Desiccation pattern on bottom of the flow of Mound No. 2

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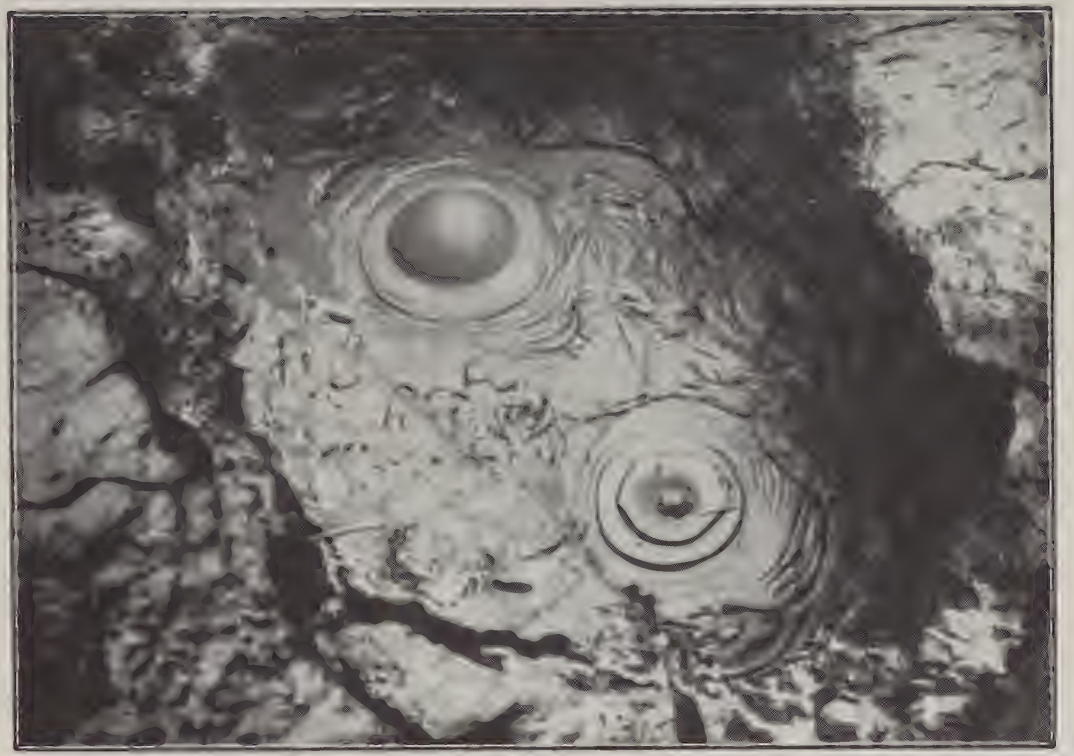


Fig. 10.—Crater of a Volcanic mudvolcanoe with gas bubbles [Beppu, Japan, 1934]

with litmus paper; its temperature was 30° C. A palm and two trees, of which one was lying on the ground, had died, presumably through a former activity of that mudvolcano (Fig. 2).

Approximately eighty yards to the west, though not such a big feature, appeared the very interesting No. 2 mound. This one was fifty-five yards in periphery, and from its seven-foot high top, out of a small, elongated crater, a mudstream was flowing and descending the slope of the mound in slow motion (Figs. 6, 7 and 8). It was ten inches wide near its origin, and its aspect (proportions and properties excluded) was very much like a miniature lava stream. No ebullition or escape of gas was observed at the orifice. The mud of No. 2 mound had, like the water of No. 1, a salty taste, and reacted in the same way. The temperature taken at a depth of eight inches near the point of issue was 29°C. (air temperature 33°C. at noon). The mud was flowing in a northerly direction over a distance of about twenty feet and spread out at its terminal end into a widening fan-shaped dejection cone. The bottom part of the mudstream showed many transverse and radial crevices formed through desiccation (Fig. 9). The flow, when measured at noon, advanced at a speed of one inch to the minute in its upper (steeper) part. A row of matches planted across the stream, after a few seconds, took on a V form, the speed being greater in the middle of the flow than on the sides. Three and a half hours later, at 15.30 hours, the mudstream advanced only with half this speed and at 17.45 hours that same afternoon it ceased to flow altogether. This coincided with a diminution of the flow of the river and the drying up of the spring of No. 1 together with some smaller springs in the area. The mudstream, yellowish-brown in colour, showed in its upper course, on the surface, a film forming grey, blue and reddish streaks, due to coloured clays and iron oxide.

From a microscopical examination by Dr. Frank Oates* of a similar stream in 1942, it appears that "the concentrate of the sandy residuum of the brine comprised several varieties of garnet, magnetite, ilmenite, zircon, rutile, epidote, diopside, kyanite, hornblende, hypersthene and tourmaline. The brine contained also in order of abundance : sodium chloride, sodium sulphate and calcium carbonate".

Near No. 2 mound, two senile ones, which had ceased working, showed many deep radial fissures, their tops were cracked and had partly collapsed. The ground south-east of these mounds was crevassed in a north-easterly to south-westerly direction. South-west of No. 2, about thirty feet distant, Nos. 3, 4 and 5 mounds were only about three or five feet high. No. 3 possessed a muddy top with some water, the others were crevassed and dry. Of the

*I acknowledge here the use in these notes of a Geological Report of the 25th March 1942 by Frank Oates, Chief Geologist of the Tanganyika Mining and Geological Department, Dodoma, by kind permission of Colonel the Hon'ble M. T. Boscawen, D.S.O., M.C., to whom I express my thanks for the hospitality enjoyed during my stay at Mtotohovu in September 1944.

southern mounds (Nos. 7 to 15 of the map) most were out of action, one or two only showing some moist spots.

As to the origin of the mudflows of Moa, the absorbing properties of a changes. The rains had filled up the pools to a greater extent but the activity of the little volcanoes was less. No. 2 mound, although mud had flown out at intervals, had not increased in height, and it was now quiet. On its top lumps of dried mud had been pushed over the crater rim. On this second visit it was also clearly demonstrated again how, through strong evaporation at midday, the water in the pools decreased, the river getting smaller and the brine of some of the lesser mounds ceasing to flow.

In order to solve the secret of these mounds, several excavating attempts were made. They proved useless until a small mound with a moist top was selected. After digging into its flank for two feet, a thick chocolate coloured mudstream under pressure bulged out and started flowing in the trench. After the latter had been filled, no further movement was noticed until digging was resumed. The clearing away of the mud was repeated several times resulting in a noticeable diminution in strength of the motive force. Finally the energy was exhausted, without a much expected gas bubble having appeared.

Before proceeding, some generalities on similar formations in other countries are essential.

Mudvolcanoes are often divided genetically into two categories: (1) those due to volcanic or postvolcanic action, found mainly in solfataras,* and (2) the pseudo-volcanic mudvolcanoes found in relation to petroleum bearing strata.†

Amongst the physical conditions required to form "eruptions" or liquid mud discharges, one can distinguish:

(a) Fine silts, clays or sands able to form a sludge with water.

(b) Active agents under pressure as escaping steam or gaseous discharges in volcanic areas, or marshgas, mainly methane, CO_2, etc., when petroliferous sediments are involved.

While mudvolcanoes of volcanic origin are usually under a more or less high thermic influence the pseudo-mudvolcanoes show mostly low temperatures. The shape of mudvolcanoes is due entirely to the modus of their discharges, the degree of viscosity of the effluents, the form of the crater, etc. They rarely attain the size of true volcanoes, their height varying between a few feet and a few hundred, although exceptions may exist.

The mudvolcanoes of Moa appear to have no relation to the origin of the hot springs of Amboni (Sigi River) near Tanga, about twenty-three miles south of Moa, arising in Jurassic beds, or to that of the hot springs north of

*Papandajan, Java; Beppu, Japan (Fig. 10); Puzzuoli near Naples, etc.

†Caucasus; Taman and Kerch Peninsulas; Baku; Burma; Islands of Rotti and Timor; Trinidad; Salvador, etc.

Moa near Lunga-Lunga, related to the igneous intrusion of Jombo syenites into the Cretaceous. The temperatures of the mudflows and the springs of Moa are low; their alterations during, or at the end of, a warm day through evaporation point to their local, very shallow, origin.

As to their association with petroleum, the report on the mudvolcanoes by Dr. F. Oates, already mentioned, is clear: "True petroleum mudvolcanoes invariably exhibit some visible olfactory signs of oil or gas." "Finally", I quote, "and this is the most important point, the structure of the sediments in the area in question is not a closed one, in other words, the strata do not form domes (anticlines) in which the oil could be concentrated and retained." One can thus assume that oil formations are unlikely causes of what Dr. Oates defines as "merely brine springs"

Scanty data on the stratigraphy of the region show the following: A few miles north, in cuttings near the Tanga-Mombasa Road, well exposed layers show a low horizon of slaty sandstones with a slight north-east dip followed by a thin layer of white calcareous material. Above it for several feet a mixture of quartz pebbles and grey marls occur, followed by reddish grits like those found near the mudvolcanoes. A boring for water at the sisal factory of Mtotohovu at a level of about one hundred feet above the volcanoes, still uncompleted in September 1944, revealed to a depth of over a hundred feet mainly sandstones similar to those of Kilulu Hill, west of Moa. The next one hundred feet showed bluish (impervious) clays with iron pyrites in seams between sandstones, while at two hundred and forty feet sandstones were struck containing some graphite and the typical minerals belonging to the basement complex.

In the light of these stratigraphical data, and if one considers the low lying "hinterland" of alluvia in the immediate neighbourhood stretching along this part of the coast known as the Digo country, with its many swamps and small lily ponds where soils are impermeable, the following hypothesis on the mudvolcanoes presents itself: On the slopes of Mtotohovu estate several springs and some wells are encountered. The springs and wells produce brakish water owing to the vicinity of the Indian Ocean. Although no chemical analysis is available, this water is not dissimilar to the brine of the volcanoes in question. It has been suggested that the watertable near the coast and the conduct of the mudvolcanoes may be influenced by nearby tidal changes. This opinion is questionable as, during both my visits, the behaviour of the flows seemed independent of the tides.

The phenomenon is obviously due to infiltration water in conjunction with the existence of impervious layers. Concerning the diurnal variations of the flows from the little volcanoes it is interesting to quote De Martonne, 1925, on similar hydrologic formations elsewhere. Writing on the watertables of alluvial plains (*nappes de plaine alluviale*), he mentions the resurgent

(*resorgive*) springs of the plain of Frioul, studied by L. de Marchi : "La surface de la nappe suit les ondulations de la surface du sol et son niveau presente une variation annuelle et *meme une variation diurne, ce qui montre combien il est sensible a l'evaporation.*" (My italics.)

As to the origin of the mudflows of Moa, the absorbing properties of a medium like clays or marls when water under pressure passes through them produces muds which surge outward. This was clearly demonstrated when some dried mud was introduced in a test tube with an equal amount of water. Within fifteen minutes the top part of the clay was dilated nearly to four times its original volume through absorption of water, forming later an impermeable layer which remained so for days afterwards.

Unlike the resurgent springs mentioned, which only produce water, the intermittent mud-bearing springs of Moa suggest a genetic association with unstable tectonical conditions likely to cause disturbances affecting the watertable. The coastline in this region, according to Krenkel, forms a fault scarp (Krenkel, *Afrika*, 1, page 288). The fracture system parallel to it (*Id.*, Taf. XVI, page 236) which one crosses on the Mombasa-Tanga Road, north of Moa, and occasional seismic activity, form contributory causes for the phenomenon and seem to confirm the hypothesis formulated above. In other countries, similar mudvolcanoes have shown veritable eruptions in conjunction with or accompanied by earthquakes : Madeira "salses", 1835; Sicilian "maccalubes", 1777; Caspian Sea, 1857, see Sapper, *Vulkankunde*, page 173; and, more recently, Baluchistan, 1935.

The mudvolcanoes of Moa, on account of their main components of brine and material from hydrophile strata, when compared with those of other categories, are distinguished by their elementary character. They represent the plain type of pseudo-mudvolcanoes.

LITERATURE

Obst, E. (1911) : *Mitteilungen Geographischen Gesellschaft*, Hamburg, XXV.
Gregory, J. W. (1921) : "The Rift Valleys and Geology of East Africa."
Krenkel, E. (1925) : *Geologie Afrika's*, Teil 1.
Martonne, E. de (1925) : *Traité de Géographie physique*, Tome 1.

Piezo-electric Quartz in Tanganyika

By B. N. Temperley

Uses of Piezo-electric Quartz [1]*

CRYSTALS of certain minerals change their shape slightly when an electric charge is applied to them and, conversely, if they are put under pressure or tension an electric charge is developed upon them. This electro-mechanical property, which is known as the piezo-electric effect, has many applications in modern electrical instruments.

Of those minerals, the crystals of which exhibit the piezo-electric effect, quartz is found to be most satisfactory on account of its other properties. Whole crystals are not used, but plates are cut from them at certain angles. An alternating current applied to a suitably cut and mounted quartz plate causes it to vibrate, and the vibration stabilizes the frequency of the current. This application of quartz plates as resonators is used in wireless transmission and, much more extensively, in telephone communication. By division of the range of frequencies into bands by means of quartz plate resonators several hundred conversations can be transmitted simultaneously on one cable.

Another application of the piezo-electric effect is in a continuous sounding instrument for attachment to the hulls of ships. A high frequency electric current causes a pack of quartz plates to vibrate for an instant, and the wave so generated, which is a highly directional one, travels to the bottom of the sea and is reflected back to the instrument. The reflected wave is recorded by the same plates in the form of an electric current. From the time interval indicated by the electric currents between the emission and return of the wave the depth of the sea is automatically calculated. A graph of soundings taken at regular intervals becomes a profile of the sea bottom, which is a considerable aid in navigation.

Quartz plates are used in research on ballistics, and it is probable that the piezo-electric effect is utilized in various instruments of war the details of which are not available.

Though quartz is one of the commonest of minerals, crystals which are large enough to be cut into plates suitable for electrical instruments are rare. In March 1943, it was stated in an American publication [2] that the supply of piezo-electric quartz had become the No. 1 strategic mineral problem. At present a large proportion of the very small total world production comes from Brazil and Madagascar, but efforts are being made to discover sources of supply within the Empire.

*See references, pages 21 and 22.

Specification for Piezo-electric Quartz

Piezo-electric quartz crystals must comply with a somewhat stringent specification. Crystals purchased by the United Kingdom Post Office Engineering Department must not be less than two square inches in cross section(3), while those accepted by American manufacturers must be at least one inch in diameter(2). In the latter case crystals of minimum width must be from two and a half to three inches in length, though if the diameter is greater shorter pieces are accepted. Crystals must be absolutely free from internal defects such as cracks, bubbles and included matter. Colourless, water clear crystals are preferred but those known as "light smoky" can be used. Samples of coloured material showing the range of colour should be submitted for test. A crystal which is partly clear and partly defective may be of use if the size of the clear portion alone is equivalent to that of a flawless crystal of the dimensions given above. Faceted crystals, that is crystals having faces, are preferred, but broken pieces and water worn crystals may be of use if their flawless portions weigh more than seven ounces.

It sometimes happens that the surface of a crystal is so dull or rough that it is difficult to see into the interior. If such a crystal be dipped into water, or better still paraffin, and examined in a wet condition, it will be found that its transparency has been greatly improved.

Quartz crystals unfortunately possess very often a structure known as twinning. The atoms are arranged in a spiral pattern, and the spiral may be either right-handed or left-handed. If the whole crystal possesses only a right-handed structure, or only a left-handed one, it is not twinned; but if it is composed of different parts, some of which have a right- and others a left-handed structure, then the crystal is twinned. If the greater part of a crystal is right- or left-handed in structure, and the pieces of opposite structure are localized at one end, or side, where they can be cut away, then the crystal is said to show surface twinning; and, if it is large enough, it may still be useful. But if the surfaces of contact of right-handed with left-handed parts descend deeply into, or cut right through, the crystal, then it is said to be deeply twinned and cannot be used unless any of the parts into which it is divided by twinning are alone large enough to pass the specification.

Twinning is of two kinds, optical and electrical, and if a crystal is deeply affected both kinds rule it out for piezo-electrical work. Optical twinning can generally be recognized because the lines, traced on the surface of the crystal by the surfaces of contact of right- and left-handed portions, divide the faces of the crystal into areas having different textures. Electrical twinning is more difficult to detect and is generally only apparent after the crystal has been cut into plates and the surface of these etched with acid.

One can readily understand from this brief account of quartz crystals and their peculiarities that their valuation is a matter for experts. Quartz crystals have, in fact, to be sent to the users in London to have their value assessed.

Crystals found or received by the Geological Division of the Department of Lands and Mines are sent to the Post Office Engineering Department, which is the largest user in the United Kingdom.

Modes of Occurrence and Sources of Supply

Quartz crystals of the quality required for piezo-electrical use have originated in three kinds of rocks, namely pegmatites,* quartz veins and quartzites†. Brazil and Madagascar are the countries with the largest production. At Fazenda Pacú([15]), the most productive Brazilian mine, the quartz occurs in veins along a fracture zone between Archaean granite and Silurian shales. The quartz is believed to have been deposited from solutions which may have yielded pegmatites at greater depths. At the Sopa diamond mine([5]) the quartz crystals occur in a quartzite formation which has been metamorphosed‡ by a diamond pipe (a type of volcanic vent). The crystals have grown in the mass of the quartzite by a parallel orientation and coalescence of the minute grains of which the quartzite is normally composed. Pegmatites are also worked for quartz crystals in Brazil.

In Madagascar([4]) the best crystals are obtained from quartzite formations which have been metamorphosed by granites. In this case the quartz has grown in caverns: most of it is in the form of crystal curtains, in which individual crystals are poorly developed, but part of it is in separate bi-pyramidal crystals which are found in the clay which partly fills the caverns. Quartz crystals occur in pegmatites also, and in both Brazil and Madagascar water-worn crystals are obtained from gravels derived from the various types of rock mentioned.

The first, and at present the only, regular production of piezo-electric quartz from East Africa was commenced in 1943 by the Geological Survey of Uganda ([6, 7]). The crystals, which were discovered in 1936, are won in the alluvial gold workings in the Buhwezu District east of Lake Edward. They are derived from veins and vugs (cavities lined with crystals) in the Buhwezu sandstones and grits, of the Karagwe-Ankolean System, which have been penetrated by granites and quartz veins.

Quartz Crystals in Tanganyika

The first record of clear faceted quartz crystals in Tanganyika is the discovery made by Colonel C. H. B. Grant, Administrative Officer, in 1925 near Mbirira north of Kasulu in the Kigoma District. The crystals average

*Pegmatites are similar to dykes in that they are sheet-like bodies of rock filling fissures; but they are composed of the same minerals as granite, namely feldspar, quartz and mica, all of which minerals have generally grown into much larger crystals than are found in granite.

†Quartzites are sandstones, the grains of which have been cemented together with quartz by natural processes; quartzites are generally harder and whiter than sandstones and often have a sugary texture.

‡Metamorphism is the alteration of rock masses in the earth by various natural processes, important among which is saturation by hot solutions issuing from intrusions of molten rock matter. The effects of metamorphism include a recrystallization of existing minerals and a re-grouping of original constituents in the form of new minerals.

only one centimetre in prism length and are therefore far too small for piezo-electric use. Nevertheless, they are remarkably perfect crystals, a number being bi-pyramidal and untwinned. They were found in gravels and surface detrital deposits in country occupied by the Uha Volcanic Series(8)*. This occurrence has not been investigated by a geologist and the origin of the crystals remains unknown. If they are derived from amygdales (bubble cavities in lavas filled with crystals), which is not unlikely, there is little chance of finding any that will be large enough for piezo-electric use.

The next record is provided by Mr. G. M. Stockley of the Geological Survey who, in 1927, found a single quartz crystal† at the top of a rocky knoll between Malangali and Mdandu in the Njombe District. This crystal, which is a magnificent specimen, is seven inches long, three in diameter, and weighs four pounds : it is absolutely free from visible internal defects, though its surface shows signs of a twinned or composite structure. The crystal was found in a pot under a ledge of rock, and the local natives stated that it had been placed there by a rain doctor to propitiate the spirits who preside over the weather. The source of the crystal was not discovered.

In 1943 a quartz crystal was sent to the Chief Geologist by the District Commissioner at Kondoa. It was an almost perfect crystal weighing one pound and three quarters. The crystal had been brought to the District Commissioner by a native who stated that he had found it in a lake in the Munguli area near Lake Selya some ten miles from Kondoa Boma. It was alleged that the crystal had fallen from the sky in the previous year; but of course it is quite impossible for a quartz crystal to have had a meteoric origin and the source of this one remains unknown.

The Discovery of Piezo-electric Quartz in Tanganyika

A point has now been reached where the writer is able to take up the story of Tanganyika quartz in narrative form, for he himself is responsible for subsequent discoveries, one of which has yielded a valuable parcel of crystals.

I began, in 1943, to make a special search for quartz crystals, among other minerals, and started work in the western Ukaguru mountains between Kidete, on the Central Line, and Rubeho, on the road from Morogoro to Dodoma. This area of country is part of the vast tract occupied by rocks of the Lower Basement Complex (hereinafter referred to as the LBC for brevity), which includes both quartzite and pegmatite, rocks from which quartz crystals are obtained in Brazil and Madagascar.

Unfortunately the quartzites of the LBC have almost invariably been subjected to a type of metamorphism which has given them a coarsely granular texture, but has never produced a parallel orientation or coalescence

*Shown as Uha System (?) Karroo on the Provisional Geological Map dated 1935, and as (?) Bukoban Volcanics on the Atlas Map dated 1942.

†Geological Survey Museum, Dodoma, specimen No. S. 1707.

of the grains such as preceded the formation of quartz crystals in the quartzites of Brazil. Moreover it appears that quartzites and other rocks of the LBC never suffered alteration under conditions which allowed cavities to remain open like the caverns in the quartzites of Madagascar. The fact is that LBC country has been penetrated very rarely by igneous (molten) rocks such as may produce the right conditions for crystal growth.

The pegmatites of the district proved equally disappointing. Pegmatites are the host rocks of mica, and from time to time mica miners find large quartz crystals which have grown in cavities in these rocks. I have examined several crystals found in mica workings, and I have myself discovered clusters of quartz crystals* on the outcrops of pegmatites, but, with the exception of those to be described presently, all the crystals large enough for piezo-electric use have been ruled out by cracks, cavities and other internal flaws. It appears, therefore, that the pegmatites of Tanganyika do not commonly provide the right conditions for the growth of quartz crystals of the necessary perfection. It is shown below that, in the case of the good crystals discovered eventually, it is probable that their high quality can be attributed to a very exceptional factor in their mode of origin.

Though I found no good quartz crystals in 1943 I obtained a valuable clue from Mr. W. A. Hall at Masenge, who told me that quartz crystals had been found at Idibo. Idibo lies near the meeting point of four provinces, the Central, the Northern, the Tanga and the Eastern, and it is situated about thirty miles west of the Nguru mountains. It was too late to visit Idibo that year so I resolved to make it the first objective of the next field season.

In 1944 I started at Kilosa and worked northwards over the eastern slopes of the Ukaguru mountains to Mamboya, and thence to Idibo. When I reached Idibo I showed the headman and his people the small collection of minerals, which I carry round with me; some of them were interested at once, a fact I attribute to the mica prospecting formerly organized by Mr. T. Bain in the district. I told the people that quartz crystals were among the most important minerals, and several of them said they would bring crystals for me to see. The first that were brought were useless, but on the second day a man named Nzola bin Tambuki brought some really fine specimens from a point seven miles north-east of Idibo near the village Chamtui (see Plate II, Fig. 1). I immediately went over to investigate and found that excellent crystals could be dug out of the soil.

Quality and Value of the Chamtui Crystals

Altogether over one hundredweight of crystalline quartz was excavated from this locality. This quantity included approximately six hundred faceted crystals or crystal fragments. The well-formed crystals ranged in size from

*Geological Survey Museum, Dodoma, specimens Nos. A. 1617 and A. 1632.

slender prisms one inch long to thick, squat masses weighing twenty pounds. The majority of them were too small or too badly flawed by fractures, cloudiness, etc., to be of any use, but thirty-three were magnificent specimens, almost certain to pass the specification for piezo-electric quartz. A further thirty, being rather small or partly clear and partly flawed, were considered worth sending to London along with the best for valuation.

The first consignment dispatched consisted of six crystals representative of the thirty-three best, including one of the largest and one of the smallest. The remaining fifty-seven good crystals were sent later after a report had been received on the first batch. Five of the six crystals of the first parcel were pronounced by the Post Office Engineering Department as easily passing Grade A of the Brazilian specification for piezo-electric quartz, which requires that sixty per cent or more of the crystal be usable. The value of the crystals ranged from Shs. 5/- for the smallest to Shs. 192/- for the largest, the price rising rapidly with the weight; and, though the report on the second consignment has not yet been received, it is anticipated that the total value of all the crystals will be about Shs. 1,200/-. This is not a large sum, but it shows that quartz crystals of the required quality are well worth digging out of the ground if deposits of them can be found.

Description of the Chamtui Crystals

The largest of the crystals of piezo-electric quality was nine and a half inches in length and two and a half inches in diameter, and it weighed three pounds. Fourteen crystals weighed over one pound. One of the finest was bi-pyramidal like those of ideal form illustrated in Plate I, Figs. 1 and 2, but most of them were complete at one end only, for they had been broken at the base (see Fig. 3) from the rock to which they were attached during growth. A very few crystals were still attached to slabs of crystalline quartz, as in Fig. 9. These slabs must have formed part of the lining of a cavity in which the crystals had grown. Several of the crystals had become detached from this crystalline lining without breakage, for they are terminated at the base by a kind of root, which has the form of a rough, irregular pyramid (see Figs. 7 and 8).

The larger crystals are more regular in shape, the smaller more interesting crystallographically. A feature of quartz crystals, well developed by the Chamtui collection, is the wealth of crystal faces which they display in addition to the common prism (column) and pyramid faces shown in Fig. 1. These additional faces are mainly those of various acute pyramids; and when they are large or numerous they give the crystal a tapering or wedge shape like that of the crystal of Fig. 4. Crystals may also be tapered by an alternation of different faces: there may be a regular step-like alternation of prism with pyramid faces, as in the crystal illustrated by Figs. 5 and 6; or innumerable repetitions of exceedingly narrow faces at different angles, as in Figs. 7 and 9.

PLATE I. SOME QUARTZ CRYSTALS FROM CHAMTUI COMPARED WITH SIMPLE IDEAL FORMS

Fig. 1

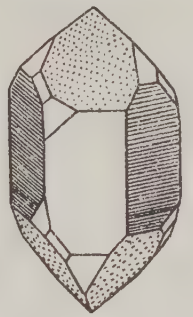


Fig. 2

Fig. 3

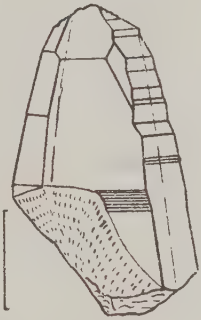


Fig. 4

Fig. 5

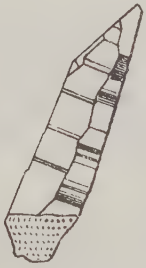


Fig. 6

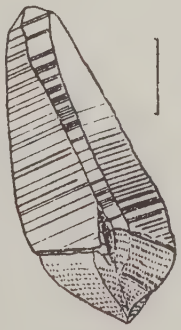


Fig. 7

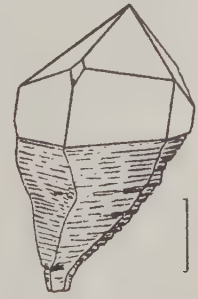


Fig. 8

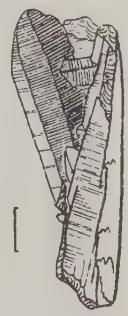
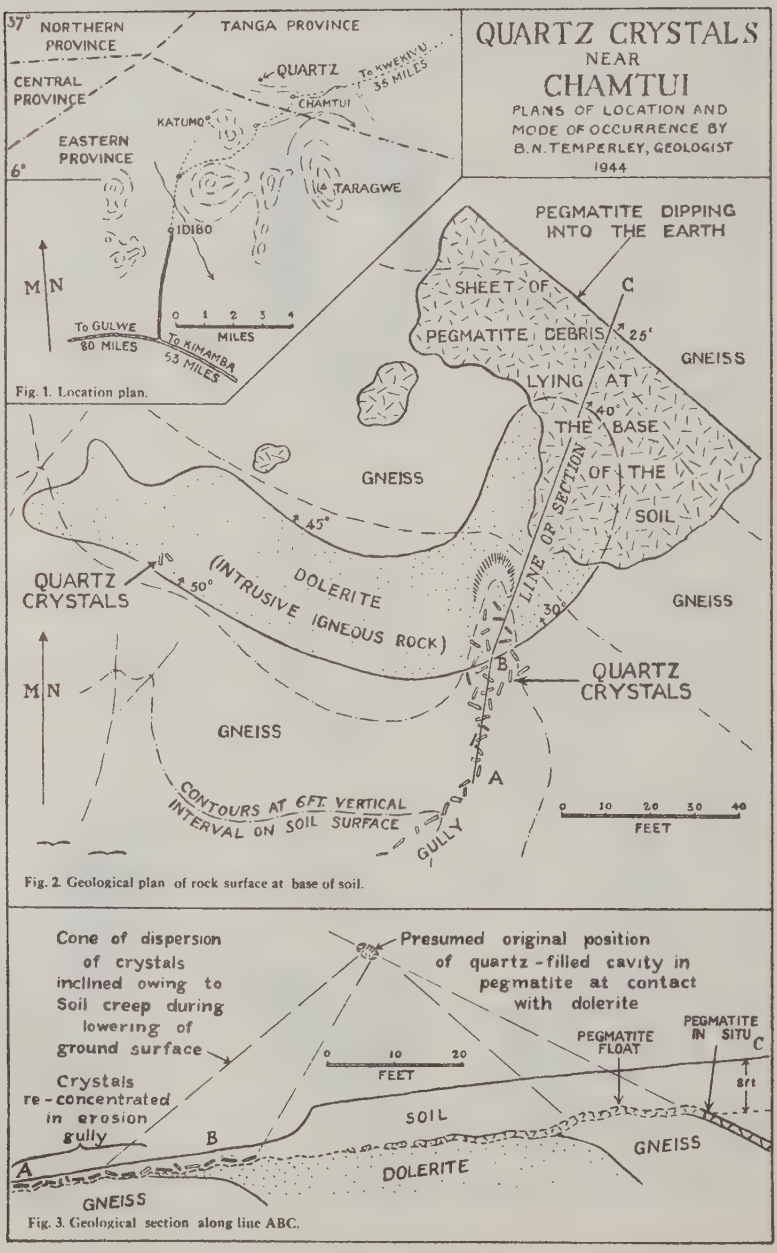


Fig. 9

The line beside each drawing represents one inch on the same scale

PLATE II.


QUARTZ CRYSTALS
NEAR
CHAMTUI
PLANS OF LOCATION AND MODE OF OCCURRENCE BY B.N. TEMPERLEY, GEOLOGIST 1944
37°
NORTHERN PROVINCE
TANGA PROVINCE
CENTRAL PROVINCE
EASTERN PROVINCE
6°
QUARTZ
To KWEKIVU 35 MILES
CHAMTUI
KATUMO
TARAGWE
IDIBO
M N
0 1 2 3 4
MILES
To GULWE 80 MILES
To KIMAMBA 53 MILES
Fig. 1. Location plan.
PEGMATITE DIPPING INTO THE EARTH
SHEET OF PEGMATITE DEBRIS LYING AT THE BASE OF THE SOIL
C
25°
40°
GNEISS
LINE OF SECTION
45°
50°
30
QUARTZ CRYSTALS
(INTRUSIVE IGNEOUS ROCK)
DOLERITE
GNEISS
GNEISS
B
QUARTZ CRYSTALS
A
CONTOURS AT 6FT. VERTICAL INTERVAL ON SOIL SURFACE
GULLY
0 10 20 30 40
FEET
Fig. 2. Geological plan of rock surface at base of soil.
Cone of dispersion of crystals inclined owing to Soil creep during lowering of ground surface
Presumed original position of quartz-filled cavity in pegmatite at contact with dolerite
PEGMATITE IN SITU
C
PEGMATITE FLOAT
0 10 20
FEET
8ft
Crystals re-concentrated in erosion gully
B
SOIL
GNEISS
A
DOLERITE
GNEISS
Fig. 3. Geological section along line ABC.

Though in their simplest form quartz crystals are bounded by groups of six apparently similar faces, as in the ideal crystal shown in Fig. 1, there is another form in which adjacent prism or pyramid faces differ. If the faces be examined in succession round a crystal of the latter form it will be found that large faces alternate with small ones or faces that are striated alternate with those that are smooth, as in Fig. 2. There are, in fact, two sets of three prism faces and two sets of three pyramid faces, and the small faces which truncate the corners where prism and pyramid faces meet occur at three corners only instead of six at each end of the crystal. This disposition of faces shows that the symmetry of quartz is not hexagonal but trigonal or three-cornered.

Many of the Chamtui crystals reveal the trigonal symmetry of quartz; see for example the alternation in the size of the pyramid faces of the crystal illustrated in Fig. 3: but this symmetry is usually masked by a tendency for the crystals to be flattened from front to back as shown in Figs. 4, 5 and 6. This flat form, which has occasionally produced tabular crystals, is probably related to the position in which the crystals grew in the cavity though the nature of this relationship is not known.

The twinning of quartz crystals has been briefly explained in an earlier section of this article. Both deep and surface twinning have been noted in the Chamtui crystals, though many of the best specimens are free or almost free from this defect. The differences in the texture of the faces of the component parts of twinned crystals from Chamtui are so slight that the crystals have to be examined with great care if the twinning is to be detected.

Mode of Occurrence and Origin of the Chamtui Crystals

The site of the crystals is near the bottom of a gentle slope which descends from a low divide to a narrow mbuga (see Plate II, Figs. 2 and 3). All the crystalline quartz occurred at the base of the soil in an area sixty feet long and twenty feet wide. The crystals would probably never have been exposed had not an erosion gully reduced the depth of the soil above them, and a native cultivated what remained. Thus most of the crystals happened to lie within a foot or two of the surface: but had they been distributed over a wider area than that affected by the erosion gully it would have been necessary to remove an overburden of tough soil, in some places as much as eight feet in depth.

Prospecting pits sunk through the soil further up the slope revealed a sheet of rock debris, derived from a pegmatite, lying, like the quartz crystals, between the rock and the soil. This lead to the discovery of the pegmatite in place sixty-five feet up the slope from the nearest quartz crystal. The pegmatite, which is a sheet of rock, slants down into the ground in such a way that it must originally have extended over, or nearly over, the area in which the quartz crystals were found. These relations indicate that the quartz crystals were almost certainly derived from the pegmatite.

This conclusion will perhaps be more readily understood if it is explained how the lowering of the earth's surface by erosion is effected during the passage of geological time. The soil surface is lowered partly by the removal of surface layers by the run off of rain water, and partly by the bodily creep of the soil mass down the slope of the ground. The rock surface below the soil is lowered simultaneously by conversion of the rock to soil. This is done by the solution of the less resistant ingredients, the solvent being rain water, which saturates the soil, charged with carbon dioxide from the air and acids from plant debris.

Here at Chamtui the pegmatite, being more resistant to decay than the rocks among which it lies, lasts longer than they do; and, as the rock surface is lowered beneath it, the pegmatite subsides on the side to which it leans. As the pegmatite bends over at the base of the soil it breaks up, and the fragments slowly creep, with the soil above them, down the slope of the ground. The quartz crystals, being the least soluble ingredient of the pegmatite, last longest and remain in the soil when all other traces have dissolved away.

It has been pointed out earlier that quartz crystals which have grown in pegmatites are usually not sufficiently perfect for piezo-electrical use. It thus becomes necessary to seek an explanation for the high quality of the Chamtui specimens. This is apparently to be found in the existence of a mass of dolerite which has a concealed outcrop between the pegmatite and the site of the crystals. Dolerite is a rock formed by the crystallization of magma (molten rock matter) which, in this case, was intruded underground. Subterranean intrusion is often accompanied by a shearing and splitting of the rocks which make way for the magma; and this enables steam, which is always present in magma, to escape from it and penetrate the surrounding rock. This steam, or the hot water formed by its condensation, may then circulate and effect various kinds of mineral alterations in the surrounding rocks.

The section (Fig. 3) shows that the dolerite magma at Chamtui very probably came in contact with the pegmatite at a point, now removed by erosion, from which the crystals might easily have travelled during the gradual lowering of the ground surface by rain wash and soil creep. Moreover, it is not unlikely that the disruption of the solid rock, which accompanied the intrusion of the magma, would involve a re-opening of the fissure in which the pegmatite was originally formed: in this way a cavity would be provided in which new crystals could grow. Further, the hot water released from the magma during its solidification might easily have dissolved some of the silica which is always present in the form of quartz in pegmatites. The dissolved silica would then be able to move into the cavity and crystallize there slowly under conditions in which perfect crystals could grow.

Though it is not possible to prove this theory of origin, some such process must have occurred, for good quartz crystals and dolerites of this kind in the

LBC are both so extremely rare that it would be a most extraordinary coincidence if their juxtaposition were fortuitous. This theory is, moreover, consistent with the mode of origin of the quartz crystals in the caverns of Madagascar: in both cases the crystals grew in cavities in consequence of the metamorphism of a siliceous rock by an intrusive magma.

Areas Suggested for Prospecting for Quartz Crystals

Quartz crystals of piezo-electric quality have been proved to originate in three ways, namely in pegmatites, in quartz veins and in siliceous rocks which have been metamorphosed by igneous intrusions (rocks formed by the solidification of molten matter underground).

It has been found that the pegmatites of Tanganyika very rarely yield good crystals, and when such appear to be derived from a pegmatite, as at Chamtui, it is probable that the quartz crystals are of secondary origin, the pegmatite having served merely as a siliceous rock which has suffered igneous intrusion. Unfortunately igneous intrusions, the effects of which have not been destroyed by later earth processes, are by no means common in Tanganyika and are very rare in the LBC which is the home of the pegmatites. Pegmatites occur almost everywhere in the LBC, which occupies more than half the area of the Territory, but they are particularly abundant in the mica mining districts, namely Mpwapwa, Kilosa, Morogoro, Bagamoyo, Handeni, Korogwe, Same, Mbulu, Kigoma, Sumbawanga, Mbeya, Tukuyu and Lindi.

While the writer was working at Idibo a native named Panganyama bin Lusasi, of Ibindu village near Iringa, who was on a journey, brought him an excellent quartz crystal weighing one pound and a quarter*. Panganyama said that he had found the crystal on an mbuga near Rubeho on the Morogoro-Dodoma road. As pegmatites, which have been worked for mica by Mr. Bain, occur in Jumbalimwe hill near Rubeho it is not improbable that the crystal was derived from one of these bodies. Panganyama also stated that he knew where crystals of the same kind could be obtained near Iringa, and that he would go and get them when he returned. The District Commissioner at Iringa has been requested by the Chief Geologist to investigate the matter to see if there is any truth in Panganyama's statement.

Another possible mode of occurrence of quartz crystals is in cavities in quartz veins such as are worked for gold in the Lupa and Musoma districts; but no good crystals from either of these areas have yet been recorded.

Siliceous rocks, in the form of quartzites and sandstones, are widespread but unevenly distributed in Tanganyika. They occur in almost all the major rock systems, but are particularly abundant in the Muva-Ankolean and Bukoban. Igneous rocks, on the other hand, intruded under circumstances which have not only allowed cavities to remain open for the growth of crystals but to remain intact through subsequent periods, are rare.

*Geological Survey Museum, Dodoma, specimen No. A. 1653.

In parts of the granitic area in the centre of the Territory small intrusive rocks are innumerable, but very few siliceous rocks were present for them to penetrate. The most promising district in the granite country is probably the Shinyanga diamond field; for diamonds occur in rock which was originally molten and rising to the surface of the earth(9). The fissures or vertical channels up which the molten rock flowed to the surface are called pipes. In Tanganyika such pipes generally penetrate granite, but as there are various kinds of rock, including quartzite, scattered about in the granite, it is possible that some of the diamond pipes may have come into contact with quartzite and produced the right conditions for the crystallization of quartz. It will be remembered that much of the quartz from Brazil occurs in quartzite metamorphosed by diamond pipes, so there is always the chance that quartz crystals have been formed in a similar way in Tanganyika. If quartz crystals have been produced round diamond pipes they will be found in the gravels of the neighbourhood along with the diamonds. No quartz crystals have yet been reported from the Shinyanga District, but that may be because their value has not been appreciated.

The areas of the Territory which should be examined most carefully are those in which rocks of the Muva-Ankole, Uha and Bukoban Systems include quartzite or sandstone, and have been penetrated by igneous intrusions. Rocks of these systems occur along the western margin of the Territory as a continuous belt in the north and a series of extensive but unconnected outcrops in the south. All three systems consist very largely of sandstones or quartzites, but igneous rocks penetrating them are of very restricted occurrence. Muva-Ankole rocks have been altered by granite in the Karagwe tinfield(11), but though the granite has come very close to quartzite at several points no actual contacts appear to be exposed. At Nyabuyonga, east of the tinfield, a large basic igneous rock (norite) has solidified in contact with quartzite, but though conditions suitable for the crystallization of quartz would be expected, no crystals have been reported. These Karagwe rocks are a direct continuation of those of Uganda, which have yielded marketable quartz, so even though no crystals have yet been found in that part of Tanganyika, the Karagwe District remains the most promising possible source in the country.

There is a large area of volcanic rocks which extends over the Kibondo and Kasulu districts of the Western Province, but no intrusive rocks were recorded when these districts were surveyed(8). Lavas, which have poured out on the surface of the earth, do not disrupt the rocks with which they come in contact, nor do the gases and vapours escaping from them permeate these to any extent: thus conditions suitable for the growth of large quartz crystals are not produced. Crystals often occur in cavities in lavas, but as these cavities were originally steam bubbles they are generally far too small to enable valuable crystals to grow in them. The finding of small quartz crystals in the Kasulu District has been mentioned in an earlier section of this article.

The Njombe District[12] offers possibilities of discovering quartz crystals, and their existence is suggested by the finding of a single large crystal by Mr. Stockley noted above. In the Magoye area in the north-west, Bukoban rocks consisting of thick quartzites and shales have been intruded by granite, though no actual contact of granite with quartzite has been seen. In the Liganga, Bulongwa and Tandala areas, south and west of Njombe, large basic masses have intruded both LBC and Bukoban rocks, but no siliceous rocks appear to have been penetrated to any extent.

Igneous rocks are almost non-existent in the sedimentary formations of the coastal belt, and are rare in the Karroo System. Intrusive rocks have been recorded near Luhembero hill[13] south-east of Mkindu in the Rufiji District, and at Kingolero hill[14] near the Kisigo River fifty miles south of Manyoni, but only at the latter point were siliceous rocks effected. The contacts of all intrusive rocks with quartzites or sandstones are worth searching for quartz crystals, but it must be admitted that the chance of finding any is not very great.

The huge masses of Tertiary volcanic rocks, of which the cones of Kilimanjaro, Meru and Ngorongoro are built, are of such recent age that they still completely obscure the related intrusive rocks which undoubtedly exist beneath them. The effusive lavas themselves are not likely to yield good quartz crystals.

In conclusion it appears that persons engaged in the mining of mica, tin and diamonds have the best opportunity of finding marketable quartz crystals, though it should be remembered that the crystals at Chamtui were found by a native while cultivating his shamba. There may be others, like Nzola bin Tambuki, who know of deposits, but do not realize the value of the crystals. It is thus desirable to give the fullest possible publicity to the facts contained in this article.

REFERENCES

(1) "Piezo-electric Quartz." *Bull. Imp. Inst.*, Vol. XXXVI, No. 2, pp. 185-196, 1938.

(2) "Quartz Crystal Shortage." *Engineering and Mining Journal*, March 1943, p. 49.

(3) "Generalized Specification for Quartz." Post Office Engineering Department, *Radio Report* No. 839, January 1943 (unpublished).

(4) Lacroix, A. "Minéralogie de la France et de ses Colonies." *Tome* 5, pp. 62-63, 1913.

(5) Walls, R. R. "Rock Crystal and Diamond Pipes in Brazil." *Geol. Mag.*, Vol. 66, pp. 111-116, 1929.

(6) "Mineral Resources of Uganda." Geol. Survey, Uganda, p. 14, 1942, and Suppls. Nos. 1 and 2.

(7) Wayland, E. J. "Notes on Rock Crystal and Reference to some other forms of Quartz." Geol. Survey, Uganda, *Bull.* No. 3, pp. 41-58, 1939.

(8) Teale, E. O. "Soil and Agricultural Development in Relation to the Geology of Portions of the Northern Kigoma and Southern Bukoba Provinces." Geo. Surv., Tanganyika, *Short Paper* No. 4, 1929.

(9) Williams, G. J. "Explanation of the Geology of Degree Sheet No. 18 (Shinyanga)." Geol. Surv., Tanganyika, *Bull.* No. 13, 1938.

(10) Williams, G. J. "The Kimberlite Province and Associated Diamond Deposits of Tanganyika Territory." Geol. Surv., Tanganyika, *Bull.* No. 12, 1939.

(11) Stockley, G. M. and Williams, G. J. "Explanation of the Geology of Degree Sheet No. 1 (Karagwe Tinfields)." Geol. Surv., Tanganyika, *Bull.* No. 10, 1938.

(12) Stockley, G. M. Geol. Surv., Tanganyika, *Annual Report*, 1944.

(13) Stockley, G. M. "The Geology of the Rufiji District including a small portion of the Northern Kilwa District (Matumbi Hills)." *Tanganyika Notes and Records*, No. 16, December 1943.

(14) Stockley, G. M. "Additional Researches on the Karroo Rocks of Tanganyika Territory." Quart. Journ., *Geol. Soc.*, Vol. XCII, pp. 1-61, plates I-VI, 1936.

(15) Kerr, P. F. and Erichsen, A. I. "Origin of the Quartz Deposit at Fazenda Pacú." *Amer. Min.*, 1942, Vol. 27, pp. 487-499, ten figs. (Reviewed in *Mineralogical Abstracts*, Vol. 9, No. 3, Sept. 1944).

The Dwarf Parrots *(Agapornis)* of Tanganyika

By R. E. Moreau

INTRODUCTION

"LOVEBIRDS", the English name by which these most attractive birds are usually known, is a literal translation of their generic name, *Agapornis*, but I cannot think it an altogether happy one. For one thing it conveys an idea of maudlin sentiment—and to no birds is this less appropriate; for another, and more important, the name "lovebird" is to some extent pre-empted by the budgerigars, which are Australian. Other peoples' names for the *Agapornis*, *Inséparable* and *Unzertrennlicher* ("inseparable"), are not open to these objections.

I have always been interested in these birds but have never had a good opportunity for studying them. My interest has lately been quickened by a request from the British Museum for information about them to be used in the forthcoming book on East African birds. It is a fact that quite incredibly little has ever been published about the habits of the *Agapornis* species in the wild state. And this is the more surprising for two reasons: first, because they are intrinsically most interesting and attractive birds; and second, because

some tribes regard them as a pest of grain crops and accordingly take an interest in them. Something has been learnt about the nesting habits of certain *Agapornis* in European aviaries, but no one knows how truly the habits of wild birds are reflected under these conditions, even for species that stand captivity as well as these do. Since getting the British Museum request for information I have searched the literature pretty thoroughly and I have badgered unashamedly most of the people whom I know to be at all interested in birds and some whom I don't. The total of the results to date shows a considerable advance in knowledge, but still enormous gaps. This preliminary summary is in fact a sprat to catch a whale. My most grateful thanks are due to all those correspondents whom I list in the references; and any one who is good enough to send me any further observations will certainly receive full acknowledgment in the more formal account of these birds I hope to publish eventually.

In one form or other the genus *Agapornis*, which is confined to Africa and Madagascar, occurs over most of the tropical belt, but there are big gaps. The genus is absent from almost the whole of Kenya. Tanganyika, with at least three different forms, which for the present I regard as species, not sub-species, has more than any other territory and the opportunities for local ornithologists are correspondingly rich. In this brief summary attention will be concentrated on the species occurring in Tanganyika.

An *Agapornis* could never be taken for a member of any family but the parrots. All have a stout dumpy build and short tail and in some degree the parrot screech. The only birds with which an *Agapornis* could possibly be confused are the three East African parrots of the genus *Poicephalus*, which also show bright green in flight. But no *Agapornis* is more than about six inches long, while the *Poicephalus* species (the so-called Brown, Brown-headed and Red-bellied parrots) range between eight and a half and ten inches. Moreover every East African *Agapornis* has the bill red, while the bigger parrots have not.

Native names have been recorded as follows :—

Kigogo (for *A. personata*) : *Mhwenzi*, at Mpwapwa(1); *Kwinzi*, round Dodoma(2).

Kinyamwezi (for *A. fischeri*) : *Nhelegani*, at Nzega(3).

In the coast towns (where the birds are not native), they seem to be called simply *kasuku ndogo*.

GEOGRAPHICAL RANGES

At present we do not know the range of any of the Tanganyika species of *Agapornis* accurately. The problem may be complicated by seasonal movements, which I suspect may be marked, but which have not begun to be worked out. The information that I have been able to collect so far for each

species is as follows :—

A. pullaria.—A West African bird that comes across to Lake Victoria and has been collected in the Bukoba District and also on Kome Island (about twenty-five miles west of Mwanza[4]), where it meets the next species, as it may do so also in Biharamulo[5]. The male has the front of the head and neck scarlet, replaced by orange in females and young birds; rest of the body mostly green.

Agapornis fischeri (rather like *A. pullaria*).—The best distinction is that *fischeri* has a broad ring of pure white naked skin round the eye and at the base of the bill. The published range is "south and east of Lake Victoria" (*Systema Avium Aethiopicarum*), including Ukerewe. This can be amplified and defined by the specimens recently collected at Mbulu[6], in the low country just west of Lake Natron[7], fifteen miles north of Kigoma[8] and at Nzega[3]. Moreover, it has been recognized as a common breeding bird on the west side of Lake Eyassi[9] and in Singida[10 11], especially towards Mkalama. This latter area is equivalent to that called "north Kilimatinde", in which they were reported as very common thirty years ago[12]. The most south-easterly record is at Suna[4], on the Singida railway about thirty-five miles north of Manyoni. So far, I do not know of any evidence that the natural range of *A. fischeri* enters the Tabora District or anywhere reaches the Central Line. This bird has been stated[4] to extend "east as far as the north-western outliers of the Kilimanjaro foothills", but the author has been good enough to inform me that he does not know the basis of this statement and I know of no definite evidence that *A. fischeri* approaches Kilimanjaro nearer than the western edge of the Rift Valley.

Agapornis personata, the "yellow-collared", has the front of the head black, a very distinct rich yellow collar, the same pure white eye-ring as *fischeri* and the same green body and red bill. Very natty. The range given in the *Systema Avium Aethiopicarum* is "interior of Tanganyika Territory, from Lake Manyara to the country north of Lake Nyasa". Actually most of the specimens recorded are from Ugogo; the Dodoma District is certainly a stronghold. Northwards I have seen it at Mondul, where Elliott has found it common in flocks up to ten and has proved it to breed[5]. It has once been recorded at Taveta[13], but I know of no record round the southern foot of Kilimanjaro, so it must be very rare there. All the same, it may extend in small numbers across extreme southern Masailand because of the specimen obtained by Fischer in the 'eighties with locality "Nguru"[14]. As his route ran nearly due west at about 5°30′ S., through Mgera, "Nguru" presumably means the extreme northern end of the North Nguus.

South of the Central Line published records are very few, but there is evidence that the birds occur near the Great North Road in very large numbers down to Chipogoro, even in flocks up to many hundreds of birds[15], across the Usangu Flats[16] and in small numbers at points on the Rhodesian border

west of Tundumu and not above about 5,500 feet([16]). Moreover they have been noticed periodically, apparently only as visitors, at the west end of the Mbeya Range, overlooking the Songwe Valley([17]).

Both the easterly and westerly extension of *A. personata* south of the Central Line is very uncertain. The *Agapornis* seen in flocks close to Kidika([18]) where the Kilosa-Iringa Road crosses the Great Ruaha, were most likely of this species. The dry, comparatively low, valleys seem to favour the eastward penetration of the species at this point, for further south the Iringa highlands and their southward extension evidently form a barrier. *A. personata* does not even occur at Malangali([19]).

On the west there is good evidence that *A. personata* does not reach Ufipa([4]) or the Rukwa depression([20]), but there is no evidence one way or the other for the Chunya and Tabora districts. The furthest west positive record is Emin Pasha's([14]) many years ago at about thirty miles south of the present Itigi Station, not far from the eastern boundary of the present Tabora District. Since then Loveridge([4]) has recorded it round the Bahi Swamp, half-way between Dodoma and Manyoni, and at Suna, where he also got a specimen of *A. fischeri*. He tells me, however, that the ascription of *A. personata* to Suna is a copying error, so that there is still no evidence of overlap between *A. fischeri* and *A. personata*. Further north *A. personata* seems to be restricted to the east side of the Rift Valley.

So far it appears that except for *A. pullaria* in Bukoba, which is more a bird of evergreen forest, and for the introduced populations in the coast towns, of which more below, the *Agapornis* population of Tanganyika is confined to the dry interior plateau, mostly between about 3,000 and 4,500 feet, rarely reaching 5,500 feet or occurring east of the line Lake Nyasa-Iringa-Kilimanjaro. Lately, however, there have been independent reports([21] [22]) of what are believed to be *Agapornis lilianae* in the west of the Rufiji District and in Liwale. These records, which are being pursued, are of extraordinary interest because *lilianae* has not previously been reported nearer than the Shire and Zambezi valleys. It resembles both *A. fischeri* and *A. pullaria* in having the front of the head and neck reddish, but not bright, rather dusty salmon-pink.* From *A. pullaria* a main difference is that the rump of *A. lilianae* is green, not bright blue, but this of course is not a character perceptible in the field. However, *A. fischeri* and *A. pullaria* seem to be completely barred off from south-east Tanganyika by the intervening range of *A. personata*. It would be extremely interesting if records of *Agapornis* in this part of Tanganyika could be amplified.

*Chapin([27]) is no doubt right to include *A. lilianae* with *A. fischeri* and *A. personata* in a group with "conspicuous bare skin round the eye". In fact it would not be conspicuous in the field: Reichnow([14]), Roberts([36]) and Belcher([37]) give no indication of any bare skin at all round the eye, while Priest([38]) quotes Sclater to the effect that the "bare parts round the eye" are "bluish flesh". These authors seem to have been misled by working on dried skins.

In addition to the foregoing "natural ranges" there are at least two places on the coast, Tanga and Dar es Salaam, where escaped *Agapornis* have maintained a breeding population for probably twenty years. European aviculturists got excited when the Yellow-collared species was introduced to them in 1925 and for a short time a vigorous export of this species and of *A. fischeri* went on. I remember seeing crate after crate of them in shops on Acacia Avenue, in Dar es Salaam, in 1928. The birds were, of course, crowded, and shipped under bad conditions, and Government stopped the traffic. Probably most of the escapes date from about this time, but something like two hundred were also set free in Dar es Salaam in 1939[17].

In Tanga the wild birds are, I think, all *A. fischeri*. As many as twenty may be seen together. I have reason to believe that they have nested in the roof of the hospital and in the crevices of a neighbouring building now demolished. They also go in and out of the nests of the Indian Swifts (*Colletoptera affinis*), where they probably also breed.

In Dar es Salaam the birds are nearly all *A. personata*. They frequent the Indian Swifts' nests on the church and breed in the roof of at least one of the European quarters[23]. It would be interesting if residents in Tanga and Dar es Salaam could make a census of the local *Agapornis* populations and gain some idea of their daily movements and feeding behaviour. In 1938-39, *A. personata* could be seen some distance down the coast past Kisiju and inland to Nzaza, twenty miles south-west of Dar es Salaam[17]. Does the same hold good to-day? In this connection it may be noted that the free-living populations of *Agapornis cana*, the Madagascar species, which existed formerly in Zanzibar and Mafia[24 25], seem to have faded out, while in Mauritius they persisted for at least a hundred years[26] and may still be there.

NESTS AND NESTING SITES

A. pullaria, the West African-Bukoba species, is the only one of which any details of nesting in the wild state have been published. As a rule it has been found nesting in holes bored in the arboreal nests of termites or ants and there is one record of it in a termite "hill" [27]. According to one reference[13] it is nests abandoned by insects that are used, but another[28] specially mentions that large biting ants were still in occupation of their globular nest in a tree although the *Agapornis* had established themselves.

The nesting of *A. pullaria* does not seem ever to have been observed in Tanganyika; and if the opportunity occurs it will be most interesting to find out whether the parrots make their own hole in the insects' nest (or, as has been suggested, take over the hole a woodpecker has made in it). Also, what are the relations between the birds and the insects? Are the latter annihilated? Is there mutual toleration? Is there perhaps even an approach to symbiosis? A curious aspect of that curious subject, the nesting of birds in association with insects and other living things[33].

A. fischeri, *A. personata* and *A. lilianae* are stated to make a "domed nest" in captivity, even when provided with a nest-box([29]), but apparently the doming is not skilful work like a sunbird's or a weaver's. It seems to be achieved by stuffing a cavity, bottom, sides and top, with rather stiff nesting material or by building up a circular wall (with an entrance hole) and laying more material over the top. The *Agapornis* seem incapable of interweaving their material. Wild nests are usually in such confined spaces that it is most difficult to get the nests out intact, even if they did not tend to fall to pieces.

Most of the exact information we have about the nests of *A. personata* we owe to the enthusiasm of Dr. W. A. Young. He very kindly sent me one of several nests that he got out of the roof of one of the European quarters in Dar es Salaam. Perhaps its form had been affected by the site, which was in the three-inch space between the tiles and the parallel boarding below it. Rough strips up to about 7 mm. wide and 180 mm. (seven inches) long had been torn from the leaves of coco palms and arranged artlessly in a pad with containing walls that must have practically filled the three-inch space. There was a lining of much thinner, but still decidedly harsh, fibres. Making all allowances for the difficulty of getting such a loose nest out of such a place (the tile had to be lifted to get at it at all), I do not think that the birds had built a dome, nor that there was room for it. This nest contained eggs (number not quite certain), besides one or two tiny bright green contour-feathers, and was perfectly clean. On the other hand another nest Dr. Young examined in the roof of the C.M.S. hospital at Kilimatinde, "a mere mass of stout dry bents (stout as twigs)" was "matted together with faeces". It looks as if the nests were used subsequently for roosting and that at that stage the birds paid no attention to sanitation. Another nest, one of those located in the roof of the hotel at Dodoma by Dr. Young, and kindly sent to me by Dr. E. W. C. Jobson, was filthy and smelt like a neglected fowl-house. It was an artless mass, about ten inches in diameter, made of fibres, probably shredded from a palm, and stiff, but altogether finer than those forming the Dar es Salaam nest, mixed with small twigs, a few bits of string and wisps of raw cotton. A very sketchy central cavity contained a few contour feathers, numerous pellets of dung and one very stale egg.

No doubt the nature of the nest varies with the site. If, as appears, the parrots use the nests of Indian Swifts at Dar es Salaam, they will not be able to do much building inside them. There was probably even less chance of their doing so in the barbet's nest with entrance only one and a half inch wide, in a tree at Mondul, where they had young([5]). Other natural tree-holes probably do not give the parrots much spare room either, except perhaps in baobabs, which the birds certainly use.

A. fischeri apparently nests in colonies among the frond-bases in the heads of palm trees([10] [30]), as well as in holes in baobabs([9]). It uses starlings' nests([31]) and in Tanga apparently also Indian Swifts' (R.E.M.). No description of actual

nests is available except for some in the court-house at Nzega[3]. "The walls of the building are of mud-brick, with about six inches of stone along the top. The nests were placed in depressions in these stones and supported against the withies which hold up the thatch. They consisted of thorn twigs untidily laid one across the other and an apology for a lining had been made from the straw of the thatch. When picked up they disintegrated as there was no weaving in the construction" (Bell).

Apart from buildings of actual nests, *A. fischeri* and *A. personata* are said to bung up the entrance to the cavity with thorny twigs[9 13 32], which they may indeed systematically remove, "park" and replace as they enter and leave[9]. Critical observations on the prevalence of this habit would be welcome.

It may here be mentioned that certain *Agapornis* spp., not occurring in Tanganyika, have been observed in captivity to carry building material by thrusting it between the contour-feathers, especially those of the rump. Nothing of the sort has yet been observed in wild birds. This method of carriage would be impossible with any but soft pliable material and is apparently inefficient even with that. The stiff material that forms the bulk of the nests in Tanganyika could almost certainly not be carried except in the beak; but the point is an interesting one, worth looking out for.

The enthusiasm with which *A. personata* and, perhaps to a lesser extent, *A. fischeri* have taken to nesting in the roofs of buildings of European type is very remarkable. In addition to the cases already cited, *A. personata* nested in at least two of the European quarters at Dodoma[15 32]; in one there are "at least three parties each of four or five birds". Years ago Loveridge[2] found them using the roof of Nzingi railway station, the next up the line from Dodoma. Here there was an interesting variant, for the birds "had pecked out grooves in the supporting beam so as to facilitate their ingress"

Nests tucked into the roofs of European buildings must, one would think, be much hotter than in natural sites. The Dar es Salaam colony was in the three-inch space between tiles and boarding. Practically all the other roofs mentioned as housing *Agapornis* are of iron and one would think that the temperatures generated under them in a place like Dodoma must be terrific. In at least one instance there the nest was in perhaps the hottest possible situation, inside the little tunnel formed by the iron ridging[15]. In such a place the insulation provided by a "domed nest" would seem to be an absolute necessity : but even the air temperature would be so high that it is astonishing the birds, whether adults or young, can endure it. It would be most interesting to obtain some temperatures inside such nests, by means of a distance recording thermometer or a thermo-couple; and also to ascertain how the incubation behaviour in such a situation compares with that in a more normal one.

I know of no published record of eggs of *A. fischeri*, *A. personata* or *A. lilianae* taken in the wild state. However, Dr. Leakey tells me that he has taken several clutches of up to five eggs of *A. fischeri*. The clutches in the Dar es Salaam colony of *A. personata* probably averaged at least six eggs[23]; and native information at Mpwapwa is that nests there contain five to six[1]. More precise information on this point is wanted. Even to the better-known *A. pullaria* this applies, because one author has given its clutch as two to three and another as five to seven[34].

The eggs of all species are white, but eggs of *A. personata* near to hatching appeared to be tinged with olive owing to the very dark skin of the embryo inside. The wisps of down on the unhatched bird were bright red, a colour not present in the plumage of the adult. Eight Dar es Salaam eggs of this species varied in length between 20·0 and 22·5 mm., in breadth between 16·3 and 17·1. A single Dodoma egg was bigger, 24·4 × 17·5.

FEEDING AND DRINKING

Throughout their range in Tanganyika the various *Agapornis* seem to be regarded as pests of *mtama*. But obviously this source of food will serve them for only a fraction of the year and for the birds' feeding habits during the remainder of the year we have only casual and scanty information. No doubt they feed largely on grass seeds—*Sorghum halepense* (which is only a "blanket" name for some of the wild sorghums) has been quoted as the staple for *A. pullaria* in West Africa[28]—but there must be a long period of the year when such seed is to be got only by searching the ground, if at all. In fact several observers mention *Agapornis* feeding on the ground[4 5 14 35]. Loveridge remarked on huge flocks in the maize fields in south-west Maswa, "where their flights and manner of feeding in the stubble reminded one of the hordes of weavers". Elliott has seen flocks feeding alongside *Histurgops* weavers near Lake Eyassi. There is an interesting record of *A. personata* in a Dar es Salaam garden "jumping up and seizing short flowering grass-heads with their bills. They then held the grass stems prone with their feet and ate the seeds off the heads as they lay on the ground" [19].

There have been suggestions that the *Agapornis* take fruit, but the only definite record I know in Tanganyika is by an African collector, who reported them eating *muhungulu*, which is Kisambaa for *Rhus villosa*, at Mbulu.

Leguminous seeds may form an important part of the diet. Pitman[39] found *A. lilianae* feeding on unripe acacia seeds in Northern Rhodesia. An *A. personata* shot by Elliott at Essimingor had been eating acacia seeds of some sort[5]. And Haldane has recently observed both the *A. personata* in Dar es Salaam and the *A. fischeri* in Tanga attacking the pods of *Cassia siamea* (Ironwood). Incidentally, he has seen the Tanga birds also eating the insignificant fluffy seeds of a Composite, *Tridax procumbens* Linn. (identified by Greenway).

Water is unquestionably important. An *Agapornis* drinks regularly and probably three or four times a day[32]. Needs must be greatly increased when a bird is spending part of its time in a stifling hole just under an iron roof and when young are being fed on regurgitated seed. It is probable that with *Agapornis* the presence of surface water may command the local distribution of the birds and determine the choice of nesting areas.

In this connection we want to know how far the birds may travel daily from roost to food and water; and to what extent seasonal movements depend on these factors.

It may be noted incidentally that from observations at bird-baths, *A. personata* do not seem at all enthusiastic bathers, entering the water with hesitation, however shallow it is[15 32].

BREEDING SEASONS

For precision I like as a rule to restrict the term "breeding season" to that in which eggs are laid. But the data available for *Agapornis* do not for the most part allow of this. Except where otherwise indicated, the statements reproduced below are tentative, based on impressions and on native information, not on examination of nests. Native information about these birds is, however, probably fairly reliable because they are such obvious, easily recognized creatures and are of such economic importance. On the other hand the recognition of the breeding season is made more difficult than in most birds because the young apparently do not leave the nest—which means they do not become visible at all—until they look just like their parents; and the parties in which these birds are practically always seen probably do not break up into self-sufficient "territorial" pairs at any season [3 32].

A. pullaria.—Perhaps as at Entebbe, May-July[13].

A. fischeri.—At Shinyanga, January-June[31]; at Nzega, May-June[3]; western Singida, about June[10], and belated young not fully able to fly seen 26th August[30]; but according to other, native, information "young come out about April-May[11]; Oldawai and west side of Lake Eyassi, eggs June-July[9]. The last record, when several clutches were collected, is the only completely definite one.

A. personata.—Data both more definite and more conflicting, for there are authentic records of nesting starting at Mondul in January[5]; eggs ready to hatch at Dar es Salaam in August[23]; eggs at the same stage at Kongwa, near Mpwapwa, in April[13]. With this the local native information that young are hatched in June at Mpwapwa[1] accords fairly well.

A. lilianae.—Probably about March in Liwale[22].

The foregoing notes indicate that May-June must be the main egg-laying season for the two *Agapornis* species of Central Tanganyika, at any rate in

Nzega, Singida and Dodoma districts. This is probably too late for the greatest amount of surface water to be available but probably fits well with the maximum in the food supply. Round Mpwapwa the period with most grass seed is probably April-May, *mtama* becomes big enough to eat in June, and acacia seeds, still unripe, first become available in quantity in early June([1]). At Shinyanga the same stages are reached rather earlier in the year([35]). It will be interesting to ascertain whether there is any real difference in the breeding seasons of the *Agapornis*.

CONCLUSION

There are apparently four species of *Agapornis* in Tanganyika, covering between them most of the country and probably of economic importance. Their geographical ranges are still not completely known and their seasonal movements, which are suspected, have not been worked out. No attempt to compare the habitat preferences of the different species can yet be made, except for the broad statement that *A. pullaria* tends to belong to an evergreen environment and the others do not. Very little that is precise can be recorded about their food. Their breeding seasons can only be sketchily indicated : there is evidence of wide local variation.

Nothing whatever has been recorded about the breeding behaviour of any *Agapornis* in the wild state. We do not know whether there is any particular display or whether "courtship feeding" takes place. We do not know to what extent the male and female share the incubation and care of the young; nor how consistently the eggs are covered; nor how often the young are fed; nor anything about the nest sanitation. We do not even know reliably the average size of clutches in the wild state : and we have not the faintest idea of the vital statistics of these important birds.

REFERENCES

([1]) M. H. French *in litt.*
([2]) A. Loveridge : *Proc. U.S. Nat. Mus.* 73 (17) : 1-69 (1928).
([3]) D. H. A. Bell *in litt.*
([4]) H. Friedmann and A. Loveridge : *Bull. Mus. Comp. Zool. Harvard* 81 : 127-129 (1937).
([5]) H. F. I. Elliott *in litt.*
([6]) R. E. Moreau : *Ibis* 1938 : 7.
([7]) E. G. Rowe *in litt.*
([8]) R. E. Moreau : *Ibis* 85 : 377-412 (1943).
([9]) L. S. B. Leakey *in litt.*
([10]) G. H. Swynnerton *in litt.*
([11]) D. W. I. Piggott *in litt.*
([12]) L. Schuster : *J. Orn.* 74 : 521-541 (1926).
([13]) F. J. Jackson and W. L. Sclater : *Birds of Kenya Colony and the Uganda Protectorate*, 1938.
([14]) A. Reichenow : *Vögel Afrikas*, 1900-1902.
([15]) F. Oates *in litt.*
([16]) J. E. Rogers *in litt.*

(17) G. G. Rushby, personal communication.
(18) M. T. Boscawen, personal communication.
(19) M. F. Stowell *in litt.*
(20) A. P. G. Michelmore *in litt.*
(21) R. de la B. Barker, and native information communicated by L. A. Haldane.
(22) C. J. P. Ionides *in litt.*
(23) W. A. Young *in litt.*
(24) J. H. Vaughan : *Ibis* 1930 : 13.
(25) R. E. Moreau : *Ibis* 1940 : 68.
(26) R. Meinertzhagen : *Ibis* 1912 : 94.
(27) J. P. Chapin : *Bull. Amer. Mus. Nat. Hist.* 75 : 240-243 (1939).
(28) G. L. Bates : *Handbook of the Birds of West Africa*, 1930.
(29) H. Hampe : *J. Orn.* 86 : 107-112 (1938).
(30) M. S. Moore *in litt.*
(31) F. L. Vanderplank *in litt.*
(32) Marion Coster *in litt.*
(33) R. E. Moreau : *Ibis* 1942 : 240-263.
(34) D. A. Bannerman : *Birds of Tropical West Africa* 2 : 412 (1930).
(35) R. J. M. Swynnerton, personal communication.
(36) A. Roberts : *Birds of South Africa*, 1940.
(37) C. F. Belcher : *Birds of Nyasaland*, 1930.
(38) C. D. Priest : *Birds of Southern Rhodesia* 2 : 294 (1934).
(39) C. R. S. Pitman : *A report on a faunal survey of Northern Rhodesia*, Livingstone : 214 (1934).

Bush Fallowing on the Makonde Plateau

By H. Gillman

ONE of agriculture's most important problems is how to maintain or restore soil fertility, and it is always of interest to study how the African has, either unconsciously or by force of circumstances, evolved various systems to overcome this ever present insecurity of a failing soil fertility. One example of how a combination of historical, geographical and vegetational agencies has given rise to such a system is provided by the agriculture of the Wamakonde, a tribe living on the Makonde Plateau just north of the Ruvuma. The system in use on this plateau is what might be termed a "bush fallow", and is of course a variation of the basic African method of overcoming declining fertility by what is less respectably known as "shifting cultivation". Many descriptions of shifting cultivation already exist, though formerly it was customary to condemn this almost universal practice; but as there are aspects of the Makonde system which are peculiar to that region, and as the successional response of the vegetation to regular clearings confers certain definite advantages to the cultivator, it is thought a description of it will be of interest.

Before discussing the value and shortcomings of the Makonde bush fallowing system it will be necessary to give a brief description of the area and of the conditions in which it was evolved. The geographical and geological details have largely been drawn from the Water Consultant's Report, No. IV, "The Water Problems of the Makonde Plateau"(1).

Geographically the Makonde Plateau comprises the country confined between the Lukuledi Valley in the north-west and the Ruvuma Valley in the south-east, and bounded in the north-east by the coast and in the south-west by the high escarpment overlooking the Masasi peneplain. It is approximately 3,700 square miles in area, and reaches an altitude of 2,640 feet in its highest north-western corner. It forms an imposing scarp face along its western end, with an average drop ranging between 1,000-1,600 feet above the adjoining plain. The eastern end of the plateau, which coincides with the coast, is much lower, varying from 150-300 feet above sea-level. The degree to which dissection has taken place differs, the western and higher end being little affected, except in the case of the Kitangari Valley, and is as yet relatively flat; whereas the eastern or coastal end is already deeply cut into by various valleys running into the sea or carrying tributaries of the Ruvuma and Lukuledi.

Geologically the plateau is built up of sedimentary formations. In the west it consists mainly of hard sandstones and grits overlying the old peneplain and its "inselbergs" carved out from the gneisses, schists, and crystalline

limestones of the lower basement complex. And in the east it is made up of tertiary limestone, soft sandstones and sands.

The soils of the plateau are mostly light sandy loams, pale orange in colour with a stiffer textured and darker coloured sub-soil, the series being very free draining. In addition there are small areas of an almost pure sand, and in some of the lowest plateau ridges near the coast are found reddish sandy loams. The fertility of all these soils is not very high, as is apparent by the fairly rapid decline in crop yields within two or three years following the clearing of the secondary vegetation. The moisture retaining capacity of all but the white sands must, however, be reasonably good, as crops can withstand fairly long spells of dry weather, and the coppicing stumps left on the cleared land remain green throughout the seven months' dry season. Soil erosion fortunately is not as yet a serious problem and the porous nature of the soils, the generally gentle topography of the plateau, and the absence of long exposed slopes has kept run-off to within fairly safe proportions. This of course does not apply to the steep scarp slopes, and to the slopes of the Kitangari and certain other valleys in the eastern portion of the plateau, where in many places erosion is already in an advanced and dangerous stage.

Water, or the absence of it, plays an important role as one of the controlling factors of the environment. For on the Makonde Plateau proper water is virtually non-existent, being found only in one or two seepage lines, one running north-south along the eastern limits of the higher plateau, the other running west-east and coinciding with the deep furrow of the Kitangari Valley. A few isolated water holes are also to be found, but their supply is precarious. The main source of water for the population of over one hundred thousand is actually below the edges of the plateau, at the foot of the scarp, and in the valleys of such rivers as the Ruvuma, Mambi, and Mbuo. Thus the location of the plateau's water entails a very large expenditure of labour in supplying the barest domestic requirements. Many villages are so far inland that distances of up to twelve miles have to be covered in getting to and from the nearest well, and even for those living near the edge of the plateau the climb down and back is no mean physical feat. Villagers often rise at three or four o'clock in the morning to start on this long journey to ensure being early at the well, for very often queues have to be formed whilst waiting for further supplies of water to seep into the wells. Why the Wamakonde have chosen to shoulder themselves with this enormous burden is a question often asked, for it would have been far more convenient to locate their villages at the foot of the scarp near their sources of water, and then if necessary climb up the scarp to exploit the obviously better agricultural conditions to be found there. There seem to be several explanations, some based on superstition. One of these relates that the original home of the tribe's progenitor was at Mahuta on the plateau, but from here he took his wife down to the Ruvuma, and there their first child was still-born. The second child was born on the Mbwemkuru River, again meeting the same fate. Thereafter they returned to the plateau,

though this time the third child was lucky and survived. Hence the natural advice to the offspring not to live in the valleys or near the "great waters", as these were abodes of sickness and death. This of course may have been an unconscious attempt at an anti-malarial measure, as was suggested by Fuelleborn and quoted in Gillman[2]. Again, the Rev. J. W. Cornwall of the U.M.C.A. has had the following reply from several Wamakonde: "We prefer to have food in plenty and go far for our water rather than to sit near the water and starve." Whatever may have been the reasons which persuaded the Wamakonde to live on top of the plateau far removed from their water, the fact of their having done so has had two important repercussions on the agriculture of the area. Firstly, as both men and women share the task of carrying water, a very large number of man hours which could have been devoted to agriculture have of necessity to be expended on keeping the family supplied with sufficient water. Secondly, as water is almost non-existent on the plateau it is impossible to maintain cattle, and as without cattle there can be no manure, there is little prospect of attempting to raise the standards of agriculture in the direction of mixed farming.

The vegetation of the plateau, of which only a very brief account can be given, mainly consists in its present stage of an impenetrable secondary deciduous scrub community often referred to as "Makonde Thicket". The study of the floral composition and the successional relationships of this thicket community has not yet been completed, but it is fairly clear that this thicket is a man-induced sub-climax, the result of clearing the original deciduous woodland formation followed by alternations of cultivation and regenerating secondary scrub.

Very little remains of the original Makonde Plateau vegetation, but small islands of this can still be seen in certain areas, especially in those localities which have been too far from water supplies, and therefore too far from the centres of population. On most of the plateau this original vegetation consists of a deciduous woodland with *Pteleopsis myrtifolia* and *Albizzia gummifera* as the dominant species, together with such large trees as *Chlorophora excelsa* (Mvule) *Bombax rhodognaphalon* (Wild Kapok or East African Cotton Tree) *Pachystelia msolo*, *Cordyla africana*, *Trichilia emetica*, *Albizzia versicolor* and *Dialium Holtzii*. It is quite probable of course that in the past *Chlorophora* held a more dominant place in the community, but with exploitation it now only appears rarely. Variations from this type of original woodland occur in the higher north-west corner of the plateau, where the dominant is *Parinarium mobola* with *Ptelcopsis* common, as well as occasional specimens of the various large trees named above. At the lower altitudes nearer the coast the more or less open *Ptelcopsis* and *Albizzia* woodland give way to a much closer type of deciduous woodland, in some cases *Cynometra* sp. and *Copaifera schliebenii* being the dominants, in others *Hymenocardia ulmoides* and *Baphia macrocalyx*. Large trees occurring in these woodlands include *Trachylobium verrucosum* (Gum Copal), *Berlinia auriculata*, *Bombax*,

and *Chlorophora*. In limited areas, where the soils are light coloured sands, the woodland is a typical "Myombo", with *Brachystegia Speciformis* dominant in association with *Isoberlinia globiflora*, *Pterocarpus Bussei*, *Afzelia quanzensis*, *Amblygonocarpus obtusungulus* with scattered thickets of bamboo, *Oxytenanthera* sp. Another type of woodland found only on the northern and western scarp edges is composed of almost pure stands of *Brachystegia microphylla*. Finally there are small areas, particularly in the north, where the vegetation is open *Combretum* woodland with various *Combretum*, *Dombeya*, *Markhamia*, *Anona Strychnos* and *Ochna* species together with *Acacia compylacantha*. The grasses found within these woodlands are *Panicum maximum*, *Andropogon* sp., *Trichopteryx* sp. and *Hyparrhenia* sp.

From the above various woodlands, excluding the *Brachystegia* and *Combretum* types, has developed the present characteristic deciduous "Makonde Thicket". Characteristic because, although floristic differences occur according to locality, the general aspect of this thicket community is more or less uniform, a dense tangle of regenerating trees, upright and scandent shrubs, many species of which are armed with wicked thorns, the whole reaching a height when mature of approximately nine to twelve feet, and, except for isolated species, losing its leaf during the dry season. There are so many species which make up this thicket, with the dominants varying from locality to locality, that it is not possible to enumerate all the types. Most of the thickets have of course regenerating saplings of the original woodland as well as most of the following, some of them upright shrubs and many of them having a scandent habit: Two or more species of each of the following: *Dichapetalum*, *Grewia*, *Fagara*, *Combretum* (scandent types), *Dalbergia*, *Markhamia*, *Cassia*, *Millettia*, *Acalypha*, also *Acacia pennata* and *A. latistipulata*, *Landolphia parvifolia* and *L. kirkii*, *Strophanthus* sp., *Rhus inamoena*, *Canthium* sp., *Uvaria acuminata* and many others, some of them new species. (Grateful acknowledgment is made for all the above identifications provided by Mr. P. Greenway, Botanist, East African Agricultural Research Institute).

In the above setting of soil, climate, vegetation and water supplies the Wamakonde have evolved, unconsciously no doubt, a system of agriculture which has in most years ensured them a sufficiency of food, and has even enabled them to export a surplus, the Makonde Plateau having for long been looked upon as the "granary" of the surrounding plains country. This system has of course many similarities to, as well as several differences from other African agricultural systems, but before discussing these the following is a general account of the sequence of operations over a period of years.

Ignoring for the moment the utilization of land under the original woodland vegetation of the plateau, the following is the sequence of operations of the "Makonde Thicket" rotation. A block of thicket which has lain fallow for a period of six to nine years having been selected, the menfolk of the family or village go in with bush knives and cut down the tangled growth, leaving

stumps approximately six to twelve inches high. This work is usually started in July or August, though there are always the more energetic ones who start earlier, with many who procrastinate until much later, either through idleness or other seemingly more important duties. It is customary to do this clearing on a communal basis, though the extent to which the whole village will turn out to help will depend on the owner's ability to produce the necessary beer. Clearing usually takes several days, and the thicket is then allowed to lie where it falls. By the end of November the thicket should be dry enough for burning, though those who delayed in their clearing will find their material much too green for a thorough burn. The exact date when this burn should take place is a question of guessing as to when the main rains are going to break, for it is not good policy to burn too soon and thus allow early showers to germinate any weed seeds before the actual planting takes place. Fortunately the density of the surrounding thicket seems to prevent the fires on the burning clearings from spreading, and only the edges of the adjoining thicket suffers any scorching.

When the rains break maize, followed shortly afterwards by sorghum, are the first crops to be planted. No preliminary cultivation or turning of the soil is practised, the seed merely being dropped into depressions left after lifting a light clod with a hoe, followed by a covering movement of the foot. The spacing is fairly wide, and when the maize and sorghum have germinated, the cultivator and his wife return to interplant with paddy. This a hill type of rice, well adapted to the rather precarious moisture conditions of the plateau, the most common type being locally known as "ngwindimba". The paddy is planted at an espacement of about twelve to fifteen inches, and when completely germinated a few cuttings of cassava are interspersed at rather wide intervals. Thus the first year's crop complex is made up of rice as the main crop, maize and sorghum as subsidiaries, and a few cassava plants as a minor crop. The maize ripens first in March and April, followed by paddy, harvested in May and early June by cutting only the heads and leaving the straw, and finally by sorghum in June or July. This first season is usually referred to as "munda", presumably derived from the word "mundu" a cutlass or bush knife.

After the first year's crops have been harvested the plot is allowed to regenerate by a process of coppicing, the numerous stumps of the original thicket soon being covered with a lush growth of suckers, which continue to remain green throughout the ensuing dry season, that is, until the middle of December. A plot thus covered with coppicing stumps is known as a "fundo", and preparation of the "mafundo" plots is rarely started until after the "munda" or first-year plots have been planted, for if done too early a fresh crop of suckers will have to be dealt with before planting up this second-year plot. When preparing a "fundo" for planting, the suckers of the coppicing stumps are lopped back and burnt. The hoe has now to be used in order to clear the remaining rice, maize, and sorghum stover, but the land does not receive a genuine turning of the soil.

The fertility of the plot in its second year has already declined too much to enable it to carry a second crop of rice, so the crop complex now comprises maize and sorghum as the main crops, with a fairly thick stand of cassava as a secondary crop. Cowpeas, green gram, sesame, watermelon, pumpkin and various cucurbits are often planted in this second year's crop complex.

By the third year, after the above crops have been harvested and the stumps allowed to coppice again during the dry season, soil fertility has declined so much that it is not considered worth the effort to re-plant grain crops. So the plot is given over almost entirely to cassava, possibly with pulses and some of the other subsidiary crops mentioned above if the prospects appear to warrant it. The preparation of the land for the third season's planting is identical with the second, the coppicing stumps being lopped back, and the old maize and sorghum stover removed by the hoe.

After the third season's cassava has been uprooted the plot is abandoned, and given over to the successional processes of the vegetation. Very soon numerous herbaceous and woody creepers and other shrubs take control of the land, and within two years the tangled growth has become dense and impenetrable again, the thicket being five to seven feet high. The woody plants then tend to crowd out the herbaceous members of the earlier community, and a few years later the whole area once more assumes the typical aspect of the "Makonde Thicket".

This regenerating process from abandoned land to full "Makonde Thicket" may take from six to nine years, though as will be described later, this period may sometimes be shortened. When the thicket is considered to be fully mature the cycle of crop-cum-bush fallow is repeated. Every cultivator will of course clear a fresh block of thicket in each year, thus ensuring that a third of his land will carry rice, two-thirds maize and sorghum, and two-thirds cassava and subsidiary crops.

For the sake of completeness it is desirable to describe briefly the cropping sequence carried out after clearing a woodland community. The clearing in this case is done with the axe, most of the trees being felled, leaving only the very large ones. As in these open woodland communities strong growing grasses such as *Panicum maximum* and *Andropogon* sp. cover the ground, it is here necessary to use a hoe in order to clear the grass. Under these conditions the cut trees and grass are often burnt in heaps contrary to the practice in the thicket clearings. The first year's crops are usually groundnuts and earth nuts (*Voandzeia subterranea*), and sometimes with sesame. Very rarely are grain crops grown in the first year of the woodland or "Jangwa" clearings. Sometimes sorghum and a little maize are grown in the second year, but groundnuts, pulses and cassava are generally preferred. The third year is devoted to cassava, after which the plot is allowed to revert to secondary growth.

It is at this stage that the change over from woodland community to "Makonde Thicket" probably takes place. Abandoned plots in these wood-

land communities soon show various members of the thicket type of vegetation colonizing small pockets of land. These grow up to be islands of "Makonde Thicket" and gradually the plot assumes an open thicket type, with small trees and grass interspersed. This plot may then lie fallow for fifteen to twenty years before it is again cleared, but when a second cycle of crops has been planted and the land again abandoned, conditions probably become more favourable for a further thickening up of the subsequent secondary regeneration. As a result the second fallow acquires more of the thicket species, and develops more of a continuous thicket aspect. Probably another, or two more cycles of crop and fallow may be necessary before the secondary regeneration following the abandoning of a cultivated plot becomes a representative thicket, a type with its full complement of the plants dominant or common to that particular locality. All this is conjecture based on a few observations of thicket appearing to invade abandoned woodland clearings, but is offered as a possible explanation for the relationship existing between the "Makonde Thicket" and the original woodland communities.

This short description of agriculture as practised on the Makonde Plateau shows that in many respects it is similar to most of the agricultural systems carried out in other parts of the Territory. The basis of these is a constant migration from land rapidly depleted of its all too meagre soil fertility, and is generally referred to as "shifting cultivation". Shifting cultivation does not usually envisage an early return to the same piece of land, mainly because the regenerating capacity of the vegetation requires anything from fifteen to twenty-five years to rehabilitate the soil. The successional behaviour of the vegetation on the Makonde Plateau, however, has apparently made it possible to telescope this rehabilitating process into a much shorter period, and the cultivator there has found that he can return to his abandoned plot within six to nine years. Therefore, contrary to the haphazard shifting cultivation of other parts, the Wamakonde have been enabled to adopt a more regular system, the cultivator practising a definite rotation made up of four courses, with rice in the first year, a maize-sorghum-pulse complex in the second year, cassava in the third year, and a six- to nine-year period of bush fallow. In this respect the system on the plateau differs from those systems practised in such regions as the Myombo country, the Orchard Steppe country, the Acacia-Tall Grass Savanna and other vegetation types. But it very closely resembles the "Mashokora" system described by Hartnoll and Fuggles-Couchman[2] for the coastal region behind Dar es Salaam, repetitions of which could possibly be found in other areas where the successional sequence tends towards a rapid regeneration of thicket communities.

The reasons why the "Makonde Thicket" rehabilitates the soil in such a comparatively short time is outside the scope of this paper, as any assumptions made should be based on careful analyses and experimentation. It is fairly obvious though that the rapid soil rehabilitation is related to the rapid and dense regeneration of the thicket community, but whether this is a

consequence of the restoration of the organic matter content of the soil that such a dense vegetal cover would provide, or whether the burning in situ of the felled thicket provides the essential addition of ash as suggested by Trapnell[3] in his description of the "Chitemene" system of Northern Rhodesia, it is not possible to say. The effect of burning the felled thicket may have a sterilizing effect on harmful organisms and thus enable the nitrifying bacteria to raise rapidly the nitrogen status of the soil during the first year or two, as is suggested in the "Rab" system described by Russell[4] or the "Taungya" system described by Thomstone[5], and as might be assumed by the fact that the crops requiring the most nitrogen, grain crops, are those that are grown in the first and second year. There is also the possibility that the resting period under this bush fallow has a beneficial effect on the soil structure in a way similar to that described by Martin[6] for land resting under elephant grass (*Pennisetum purpureum*) or other grasses. Whatever effect the root system of the various thicket plants may have on the structure of the soil, they do appear, by their relatively deep nature, to provide the necessary reserves to enable the stumps to coppice successfully and rapidly even after three years of lopping back, and thus assist in the early re-establishment of a dense cover. If one or all of these suggestions does not entirely explain the cause of the restored fertility, the mere fact of having a period of rest must allow natural weathering processes to make good to some extent any loss in fertility.

However tardy nature may have been on the plateau in its provision of water and soil fertility, it has nevertheless, in the successional behaviour of the vegetation, enabled the Wamakonde to develop a reasonably secure system of agriculture. Shifting cultivation has of course many disadvantages, the most serious one to the cultivator being the amount of labour entailed in felling the trees or bush, and the limitations this imposes on the area he can cultivate. And where the regeneration of the vegetation is slow or of an open nature, and soils, topography, and the distribution of the rainfall encourage rapid soil erosion, then shifting cultivation becomes a menace to the agricultural potentialities of that area.

On the Makonde Plateau, however, though the labour output in clearing thicket may be high, the system of shifting cultivation, or preferably bush fallowing has everything to commend it. It solves the problem, where not abused, of restoring soil fertility, and at the same time provides a useful means of reducing to the minimum any damage due to erosion. This protection from soil erosion can be said to be complete during the fallow periods, and more than partial during the period of cultivation, the cut over stumps offering a check to any wash that may occur. This of course does not apply during cultivation periods where the land is on the scarp edges and slopes, where erosion is already a menace.

But there is still the one serious limitation in that a bush fallow system requires a considerable amount of land per family to maintain the rotation

and provide the necessary period of rest, although shifting cultivation in the non-thicket type of country requires an even greater reserve of land. But to curtail the period of rest allowed under "Makonde Thicket" must interfere with the rehabilitating processes of the soil, and will result in a lower fertility status in the next cropping cycle. This in its turn may entail the shortening of the cropping cycle from three to two years, therefore requiring more land again to produce the same amount of food, and introducing also the danger that subsequent regenerations will take longer, and that eventually the thicket type may deteriorate from its present luxuriance to a more open and less beneficial community.

At present land requirements on most of the plateau would appear to be approximately fifteen to twenty acres per family, basing this on the assumption that each family clears about one and half acres of thicket each year. With three one-and-half-acre fields under cultivation, and six to nine years under bush fallow the total area works out between thirteen and a half to eighteen acres per family. In certain regions of the plateau, especially near Mahuta and Newala, the population density has been rising, largely as a result of the improved birth to mortality ratio. Here the pressure of population has already encroached on the fallow period, and the natives report that they are having to curtail the bush fallow period to as little as four years. No striking repercussions may as yet be observable, but it will not take many generations before such an interference with the equilibrium established between cropping cycle and resting of the land under thicket will produce serious consequences.

The rise of population on the Makonde Plateau, therefore, poses a serious problem, and the alternatives are either to check this population pressure, probably by a policy of emigration, or else to develop an alternative system to the present one of bush fallowing for the purpose of restoring soil fertility. Such alternative systems might include a policy of mixed farming, the importation of fertility in the form of artificial fertilizers, or the adoption of a different type of rotation.

The absence of water on the Makonde Plateau immediately introduces an insurmountable handicap to the establishment of herds of cattle, and until the problem of providing ample water over the plateau area has been solved, a system of mixed farming cannot be considered. Goats of course there are, but it is doubtful whether they could ever be relied upon as a useful factor in some modified system of mixed farming. Manuring is therefore out of the question, though perhaps a small body of enthusiasts might develop a system of composting applicable to the waterless and almost grassless conditions that prevail on this plateau.

The importation of artificial fertilizers is also not practicable for a population with such low standards of living and wealth.

This leaves the modification of the present rotation as the only possible solution that might offer some relief. Such modification might substitute some exotic resting crop to replace and enhance the functions of the present

natural bush fallow, but whether such an artificial and of necessity exotic resting crop will prove suitable is impossible to say without a long-period trial. In Uganda a resting crop such as *Pennisetum pupureum* (elephant grass) has proved to be useful in restoring the soil structure and fertility, but whether *Pennisetum purpureum* would prove to be suitable under the very much drier conditions of the Makonde Plateau is doubtful. A local *Pennisetum* sp. actually exists, and is found colonizing roadsides and what appear to be mishandled blocks of land. As such, one might assume it to be an indicator of poor soil, and of doubtful value as a restorative crop. The problem of finding a suitable alternative resting plant or complex of plants would no doubt prove a very lengthy process, and it will not be easy to find an alternative fallow which can be established as rapidly as the "Makonde Thicket" restores itself to a full soil cover. The additional work of establishing and later removing an artificial resting crop such as *Pennisetum purpureum* would compare unfavourably in the eyes of the African cultivator, who would think working with a bush knife clearing thicket the less arduous task. A grass ley on the other hand would be of little use without cattle to maintain it, as the competition with the local vegetation would be severe. It is problematic also whether a short rooting community such as a grass ley could compare favourably with the much deeper rooting thicket community. A rotation without any fallow, but using leguminous crops might provide the solution, even if two seasons had to be sacrificed to growing crops which would provide only a token harvest. Again, trial and error would decide this.

At present the prospect of finding some simple, cheap and practical alternative to the system of incorporating the "Makonde Thicket" into a rotation is not very hopeful, and therefore any policy which aims at maintaining the present standards of living of the Wamakonde must be prepared to accept the value of this system. For not ony does it provide the necessary simple and practical way of restoring soil fertility, but it also has various other advantages. The historic one of providing cover from Angoni raiding parties no longer applies, but besides the not unimportant advantage of providing unlimited building material and fuel, the "Makonde Thicket" does serve the very useful purpose already described of reducing run-off and arresting soil erosion. The scattered clearings in this overall blanket of thicket are seldom located together to form long continuous open slopes offering conditions for increased run-off, but should the tendency to do this develop, some simple Native Authority rule could possibly induce the cultivators to stagger their plots and thus achieve a sort of strip cropping effect.

Acknowledging therefore the value of the "Makonde Thicket", and having arrived at the optimum period during which a soil resting under it can be said to have been rehabilitated and to be fit again for cultivation, the policy should be so to control the density of the population on the plateau as to ensure that bush fallow is not jeopardized by any shortening of the resting period. As the Makonde Plateau cannot afford the luxury of any further great

increase in its population, it would be far better to sacrifice the convenience of the emigrated few in order to preserve the heritage of the all too scanty fertility of this area, an area so luckily favoured with an environment and vegetation complex that has provided the necessary conditions for developing a stable system of agriculture.

REFERENCES

(1) Gillman, C. "The Water Problems of the Makonde Plateau". Water Consultant's Report No. IV (MS.), 1940.

(2) Hartnoll, A. V. and Fuggles-Couchman, N. R. "The Mashokora Cultivations of the Coast". *Tanganyika Notes and Records*, No. 3, April 1937.

(3) Trapnell, C. G. "The Soils, Vegetation and Agriculture of N. E. Rhodesia" (1943).

(4) Russell, E. J. "Soil Conditions and Plant Growth", 1932.

(5) Thompstone, E. "Agriculture in the Shan States with Special Reference to the System known as 'Taungya Cultivation' ". *Agr. Jour.*, India, Vol. XVI, 1921.

(6) Martin, W. S. "Soil Structure", *East African Agricultural Journal*, IX, 4, April 1944.

Linguistic Notes from the Southern Province

By the Rev. Lyndon Harries

PART 1

AMONG the linguists who have attempted to record the Bantu languages spoken in the Southern Province of Tanganyika Territory, Meinhof is the only one who studied any one of these languages from the comparative point of view. In the *Mitteilungen*, his brilliant studies of the phonology of Yao and Makua illustrate the relationship of these languages to comparative Bantu, but no one has yet been sufficiently acquainted with all the languages spoken in the Southern Province to indicate their comparative relationship with one another. Maples and Woodward were the best of the earlier linguists in the Southern Province, but the value of their contributions to Bantu linguistics is inevitably lessened because of their old-fashioned method of approach to the study of a Bantu language.

It was not until Meinhof himself introduced the system of comparative Bantu research that students were able to recognize the inter-relationship of one Bantu language to another. Differences of vocabulary in, say, Makua and Yao, may suggest to the student immersed in the exclusive study of either of these languages that they are very different from each other, whereas by application of the comparative method it is made evident that Yao and Makua are closely related.

Similarly, in the Southern Province we find that the Makonde, Mawiya (Mawiha), Maraba, Makua, Matambwe, Ngindo, Ndonde, Mwera and Yao languages are all closely related, not simply because they are all Bantu languages, but because they all belong to the same cluster, the Yao cluster, of the south-eastern zone of the Bantu family of languages. This classification is not merely a geographical one, but is based upon the affinity of one language to another, although, of course, the geographical position of the respective tribes has some bearing on this affinity. The immediate standard of comparison for all these languages is the Yao language. Of the other two languages spoken in the Southern Province, Ngoni has close affinity to Zulu, and Matengo to the Nyanja group in Nyasaland. For the purpose of these brief notes we shall refer especially to the Yao cluster of languages, a happy hunting ground for the linguist in the Southern Province. It is significant that most speakers of these languages can converse in Yao, but the Yaos themselves are not all able to speak in any one of the other languages of the same cluster. This, in itself, is not the only reason for postulating Yao as the predominant language, in fact it might suggest quite the opposite, but as a rule such a phenomenon confirms the conclusion arrived at by scientific study of the separate languages.

Part 2

It may be of interest to consider how these languages compare with Swahili, and what is the influence of Swahili upon them. Swahili is, of course, a Bantu language with typical prefixal formation, and it might be thought that the differences are largely a matter of vocabulary. This is not really so. These tribal languages possess a wealth of idiom and construction not found in Swahili. If, as Sir Arthur Quiller-Couch asserted, in all civilized speech the verb is the very nerve of the sentence, so in all primitive Bantu speech the verbal and adverbial idea expressed so frequently by the use of that part of speech known as the ideophone is the very nerve of the Bantu sentence. In all the languages of the Yao cluster the ideophone is a most important part of speech. It is a word, often onomatopœic, which expresses the verbal idea in respect to manner, colour, sound or action. An ideophone is often used by itself when the context is clear, as if we should say "plonk" in English for "it went plonk", and the accompanying verb is frequently omitted.

Influenced so strongly by Arabic, Swahili is what we sometimes like to call "a more civilized" language than any of the tribal languages. The ordinary verb in Swahili behaves "in a more civilized way", and usually contains in itself the idea expressed by the tribal African in his own language by the use of an ideophone. We know that many verbs in Swahili are of ideophonic origin, but the pure ideophone is not employed so frequently as in the tribal languages.

For instance, in Swahili the verb "kupindua" means "to turn over", and is derived from the ideophone "pindu", which is now very rarely heard. Whereas the Swahili speaker says, "Musa alipindua jamvi", "Musa turned a mat over", the speaker of any one of the languages of the Yao cluster prefers to use the ideophone, as if he were to say, "Musa went pindu to a mat", or, "Musa and a mat, pindu!". So that without a knowledge of the hundreds of pure ideophones in the Yao cluster of languages, ranging from monosyllabic to quadrisyllabic ideophones, it is practically impossible to follow any connected speech.

A Basic Swahili on the lines of Basic English could perhaps be worked out excluding ideophones, but no basic form of any one of these tribal languages could be without them. They are, in fact, the basis itself of primitive Bantu speech. Even when speaking Swahili the tribal African of the Southern Province often introduces ideophones from his own language because to him expression of what he wants to say is not complete without them.

The fact that Swahili has, from the very earliest days, had a considerable written literature, may have something to do with the comparative scarcity of ideophones in the language. One of the effects of transcribing a Bantu language is that the ideophone tends to drop out and the ordinary verb supersedes it.

This is one of the characteristic differences between written and spoken Bantu, that in the literature of the language the ideophone is generally excluded. The languages of the Yao cluster are transcribed only for the simplest purposes, like private correspondence between Africans, a few prayer-books and translations of the Gospels. In none of these is the ideophone transcribed, although the tribal speaker would readily admit that in actual speech he would frequently prefer to use an ideophone where the written sentence employs the ordinary verb. It is the transcription of a language that sets it on the way to becoming "a civilized" language, and the ideophones are discarded in the process.

Generally speaking, the only form of literature read by speakers of the languages of the Yao cluster is in Swahili. Any attempt to transcribe these languages by employing the present Swahili orthography is bound to end in failure. The reason for this is that there are sounds occurring in these tribal languages which do not occur in Swahili and for which there is no proper equivalent in the Swahili orthography. The people have become so accustomed to Swahili orthography that they prefer to write their tribal language just as Swahili is written, but the result is most unsatisfactory in many respects. In Makua, for instance, there are six consonantal sounds which do not occur in Swahili, and to use the nearest equivalent in Swahili orthography is at the best only a feeble compromise. A learner would never be able to guess the proper pronunciation of certain Makua consonants merely from the orthography now employed, and there is no way of distinguishing nouns alike in form except for the consonant, when two consonantal sounds are represented only by the same letter. To write "th" (the sound in the Swahili word "thamani", or in the English "thin") for the Makua dental consonant which sounds like t+th, as in the English word "eighth", only leads to confusion. Mass literacy in the vernacular of most tribal languages of the Territory is quite out of the question, even if there were a demand for it, so long as the Swahili orthography is the only one employed.

But, it may be asked, with the spread of Swahili throughout the Territory, will not the tribal languages eventually die out, or at least be so influenced by Swahili as to lose their distinctive character? If the languages of the Yao cluster may be taken as providing an answer, it is quite clear that there are no signs whatsoever of these languages becoming extinct, nor even of their losing their separate characteristics. Just as Swahili is enriched by borrowings from other languages, like English, so these tribal languages are enriched by borrowings from Swahili. It is inevitable that as certain Swahili words take the place of the tribal equivalents, the latter may become obsolete, but this makes no difference to the particular genius of the tribal language. The process is one of adapting Swahili to the tribal language, and not vice versa. When, to take a simple example, in Mwera the Swahili word "haraka" is borrowed, it is pronounced "alaka". It has ceased to be a Swahili word when this happens,

and is now a Mwera word. In each of these tribal languages, Swahili borrowings are adapted according to the regular phonetic principles at work in the respective language. It is not that a Mwera speaker is incapable of pronouncing the Swahili word in the Swahili way. He often does so when he is speaking Swahili, but when he speaks his own language he prefers to conform to the phonetic principles of the language of his birth.

Part 3

These phonetic principles have a much wider range in the languages of the Yao cluster than in Swahili. For instance, coalescence of vowels takes place in Swahili, but the range of coalesced vowels is not so wide as in these tribal languages. In Mwera, for instance, there are no less than twenty-four different cases of coalescence resulting from the fusion of adjacent vowels. Similarly in Makua there is a very wide range of coalesced vowels.

Again, the tone values of words and phrases in the Yao cluster are far more important than in Swahili. Although none of the languages of the Yao cluster can be called a tone language, there are distinct traces of their once having been so. There are verb forms and nouns differentiated in meaning only by the tone employed.

These phonetic principles not only distinguish the respective languages of the Yao cluster from Swahili, but also from one another, and it is as fascinating as any jig-saw puzzle to identify the principles and so discover how words, at first apparently so different, are really the same in origin. By this method of study we find that Mwera, spoken on the Rondo Plateau, more closely resembles Yao than any other language of the same cluster; that the languages of the Makonde Plateau, Makonde, Maraba and Mawiya, are a stage further away but resemble one another very closely; that Matambwe, Ndonde and Ngindo go together; and that the Makua language stands alone as being furthest from Yao and yet belonging to the same cluster. Each of these languages has dialects of its own; for example, in the Masasi District one can hear the Imitupi, Ikorovera and Imeto dialects of Makua. The linguist can, if he tries, find order in this babel, but, perhaps, for most of us, Swahili is enough to be getting on with. That may be so, but what a lot we miss!

Notes on Native Methods of Fishing in the Mafia Islands

By B. J. J. Stubbings

THE SUBJECT of fishing in the Mafia Channel has already been dealt with comprehensively by Messrs. Cole and Piggott in *Tanganyika Notes and Records* Nos. 3 and 12 respectively, but the subject has been treated by these writers from the point of view particularly of the European angler equipped with motor-boat, and trolling apparatus. These brief notes refer only to the different methods employed by native fishermen. The fishing industry plays an important part in Mafia life and economics as the fishing in this area is particularly good.

It is not claimed that these notes are complete nor that the methods described are peculiar to Mafia. Indeed many of them may be seen almost anywhere on the East African coast.

I am indebted to Selemani Athmani and Yusuf Ali, crew of the Government motor-boat, for most of the information contained herein.

The different methods may conveniently be classified into three main divisions, Line, Trap and Net.

A.—Line Fishing

1. For this a handline is used. The thickness of the line and size of hook naturally depends on the type of fish which is wanted, but practically all kinds of fish can be caught by line. *Ngalawas* and *mitumbwi* (canoes) are used by the fishermen, but sailing canoes are not so common in Mafia as elsewhere. The hooks are usually bought in the shops, but local smiths also can make them. The line is made of cotton thread bought in the shops and woven to the required thickness by specialist *fundis*. It is then treated with a black dye and preservative made from the roots of a shrub, known locally as *Mpesi* (Kiswahili: *Mkasiri* (*Phyllanthus reticulatus*). The completed product is remarkably strong. In line fishing, the bait may be grounded completely, or may be suspended at some distance above the sea bottom, depending on the type of fish required. Sand shark (*papa*) and barracouta (*mzira*), much favoured as sun-dried *ng'onda*, are often caught by this method. Favourite baits used are *kowana*—a small silvery fish (bream) which is very good eating itself, or, better still, *ngisi* (squid) or *pweza* (octopus).

2. The other common method of line fishing is trolling. In October and November each year about ten to fifteen sailing boats, usually twenty to thirty feet overall length and fast, are to be seen trolling round the sand spit Fungu Sefu in the Mafia Channel—a famous ground for king-fish (*nguru*). The boats come from as far afield as Zanzibar and Mikindani especially for the

season, and recently the yacht *Osprey* from Dar es Salaam had good sport with the fleet. A remarkable feature of this fishing is the regularity of the hours kept. From dawn till noon and from three o'clock until sunset are almost invariably the only times when trolling is done (*vide* Cole op. cit.). At other times, the boats anchor in the lee of the sand-spit or proceed to Kilindoni to water and provision or collect bait. The bait used is again the *kowana*, but, as no swivels are used* the bait has to be carefully tied to avoid twisting of the line. The hook is inserted in the mouth and comes out of a slit made in the side of the fish. The bait is then twisted once again lengthwise round the hook which finishes up in the tail of the fish. The mouth of the bait is then firmly sewn with thread to prevent waterlogging. Occasionally coloured cloth lures are used instead of bait. Good catches of *nguru* are made, and the catch is sun-dried and sold as *ng'onda* to hawkers (*wachuuzi*) who come down from Dar es Salaam and elsewhere for the season.

3. *The "Konge" method.*—For this a twisted fibre line about one-eighth of an inch thick, made from a species of Sansevieria (*mkonge*), and about six fathoms long is used. To this line are attached at intervals of four or five inches short "traces" of twisted thread; at the end of each "trace" is fixed the hook. The hook is made of a thorn from the lime tree (*mndimu*) and is shaped in a very open V, only one end being the natural thorn point, the other not being very sharp. The distance between the extremities of the arms of the hook is slightly less than half an inch. The hooks are baited with small pieces about two inches long of a long worm (*daa*) dug up in the muddy part of the shore. A stone is attached to one end of the fibre line and the other is tied to a thin sapling, usually with a few leaves on top. The fisherman, when the tide is high, wades out until he is waist deep. He then drops the end with the stone and walks along parallel to the shore paying out the line. At the other end he sticks the sapling in the sand with the leaves showing above water. The bait is then lying on the sand. The fisherman retires to the beach and watches the sapling which is agitated slightly when fish are hooked. After a short interval he wades out to the sapling and hauls in the line and inspects it for fish. Usually, if the fish are biting, five or six are hooked at a time. This method is only used for catching small *chaa*—a silvery fish about eight or nine inches long, and good eating; (the *chaa* grows bigger but larger fish are not usually caught this way). The fish are firmly hooked as the trace thread is made fast to the join of the arms of the V, and although the hook can be swallowed sideways it cannot be readily ejected.

B.—Trap Fishing

1. *The "Dema" method.*—The *dema* is a fish-trap of open wickerwork, circular, and of about three feet diameter and one foot high. It is similar in principle to most fish traps of this type, having a "funnel" built into the

*H. J. Powell reports that in the Dar es Salaam area swivels are used by natives.

trap which narrows at its inner end, allowing comparatively easy entry but making exit almost impossible. The traps are baited with very much decomposed "bêche-de-mer" known locally as *majongoo*, or with mussels (known as *mapanga* because of their very sharp edges) with the "meat" exposed, or with the "meat" of *majeta*, a kind of large clam, or small worms (*mwata*) or even with a parasitic weed which grows on mangroves (local name, *yasi*). The trap is sunk in about two or three fathoms where it can easily be collected at low water, and is not buoyed in any way, in order to prevent theft.

2. *The "Mingono" method.*—*Mingono* are traps made of split bush withies or split bamboo tied closely and shaped something like a large elongated *pakacha*. (The *pakacha* is the common basket of plaited green palm fronds.) The trap is approximately three feet high and one foot in diameter. The entrance is a "funnel" in the top of the trap and the trap is sunk in one or two fathoms and anchored with stones. The bait used is the same as for *dema*, but *kisamvu* (cooked chopped cassava leaves) is also used. The traps are put out on a rising tide and inspected on the following falling tide. They are not left for a full day as is the *dema*; the traps are marked by sticks to assist in locating them as they are used largely by old men whose eyesight is no longer sufficiently good to locate *madema*. Neap tides are considered the best time for these traps. In twenty-four hours a fisherman will probably set his *mingono* two or three times.

3. *The "Wando" method.*—(Kiswahili: *Uzio*). This is defined in Johnson's Dictionary as a fish trap consisting of a fence of upright sticks fastened together, and used for enclosing an area, sometimes very large, on a sloping tidal shore, and preventing the escape of fish as the tide falls. In amplification of this definition it should be stated that the fence is open on the shore side. Fence poles about one inch thick are stuck into the mud at suitable intervals round the boundary of the area to be enclosed, and to these are attached the fence consisting of thin sticks of coconut palm leaf ribs, about the thickness of a match, and about two feet high, bound very closely together with fibre made from *miaa* (leaves of dwarf palm—*Hyphaena coviocea* or *H. crinita*). Sometimes the sticks are also made from ribs of dwarf palm leaves. These traps are to be seen all round Mafia island, but they are moved according to the monsoon to avoid unnecessary damage by heavy seas. At low tide, the traps are visited and the fish collected.

C.—Net Fishing

1. *The "Juya" method.*—The *juya* is a drag net made entirely of *miaa* fibre. It varies in length but is seldom less than ninety feet long exclusive of the eighty- or ninety-foot long hauling ropes (*mgwe*). The net (*tupo*) has approximately three inches mesh and is about five feet wide except in the middle where there is a large bag-like affair of much finer mesh, called the *jumba*, whither the fish are eventually driven and caught. For *juya* fishing a large

number of men, about twenty at least, is required, who set out in a *dau*—a small fishing boat, sharp at both ends. One set of hauling rope is dropped with two or three men in water about four to five feet deep. These remain while the *dau* proceeds paying out the *juya* as she goes. When it is all paid out, some of the crew get on to the hauling ropes at each end and pull the net in while others beat the water and shout to frighten the fish into the net. It is hard work dragging in the net but often very large and profitable hauls are made by this method, which is popular as a result. The most noted exponents are the natives of Dongojekundu and Tumbuju villages on Mafia Island.

2. *The "Jarife" method.*—The *jarife* is a drag or seine net, made in the European fashion of thick twine, with approximately two-inch mesh, but is not normally used as a drag net. It is used principally for catching *kapungu* sharks and occasionally turtles are also caught. There is reputed to be a very unpleasant type of shark, the *amrani*, which goes out of its way to destroy *jarife* nets by cutting them with its teeth. The net is usually anchored firmly at each end, but the middle is left very slack and floats are tied at intervals on the upper edge and weights on the lower to keep the net upright. It is placed in channels frequented by sharks and apparently when a shark gets caught, his own violence causes the slack in the net to enmesh him still further; it is a specialist's job to untangle a fish when caught in a *jarife* without spoiling the net. Bwejuu and Jibondo islanders are the principal *jarife* users.

3. *The "Wavu" method.*—The *wavu* is also a European-type net with floats and weights on opposite edges but has a smaller mesh and is used as a drag net by four or five persons. Usually two drag on each haul and the other drives the fish into the net. The net is a comparatively small affair, and one method of casting it is with long poles. The *wavu* is not greatly used.

4. *The "Kimia" or "Gimia" method.*—The *kimia* is a circular casting net of light fine twine with small mesh, usually operated by one man only. It is a small affair and only small fish, slightly larger than the *dagaa*, are caught (for which see under 5 below). The net has light weights of metal or stone on the bottom to assist in the casting and ensure its sinking and small wooden floats on the top edge. It is not much used in Mafia, but has been seen in use at the river mouth at Kisiju (Uzaramo District).

5. *Kutanda dagaa.*—Although strictly speaking this is not "net" fishing, the method is very similar. It is the means by which native women catch *dagaa*, similar in size to whitebait, by using a large sheet of calico. The women each take a corner of the sheet while others splash and drive the shoals of small fish into the sheet which is deftly whipped out of the water at the right moment. This is a common sight in the shallows and creeks where *dagaa* are usually found, and may also been seen almost any day in the creek at Dar es Salaam on the way to the King's African Rifles Cantonment.

Another method of fishing, which has not been seen elsewhere, is that used for catching *ngogo* in the shallows at low spring tides. *Ngogo* are small fish about four or five inches long, with very sharp spines, rather like whiskers,

curiously unfishlike tails, and are altogether singularly ugly, but reputed to be very good eating. These fish are to be found in the small hollows in the muddy, sandy shallows where seaweed grows. Again, it is usually women who take part. The method is as follows: Having located the fish (not very difficult at low tide) the woman picks up a black sea-slug (bêche-de-mer, but not the Chinese edible variety) and immerses it in the pool and rubs it with sand. It then gives off some sort of intoxicant which temporarily dazes the fish which comes to the surface in a drugged and lethargic condition. It is then very neatly struck just behind the head with a sharp knife and caught by the tail and put in a bowl. The women seldom miss with their very quick knife strokes. Great care is taken to avoid contact with the sharp spines which are removed as soon as possible after catching the fish. The spines are reputed to be poisonous, and are certainly painful. It is rumoured that some women, if they get pricked, go temporarily mad and tear off their clothes and scream, but this interesting spectacle has not been witnessed.

In addition to the above-mentioned methods of fishing, shell-fish, particularly oysters and mussels, are collected, but there is nothing noteworthy about the methods used. Before the war, bêche-de-mer was collected and sold to Chinamen for export.

Much of the fish caught is sold fresh locally, but the *ng'onda* or dried fish trade is more profitable and nearly all sizeable fish are dried for this purpose.

Game in relation to Tsetse

By S. Napier Bax

MR. RUSHBY in his article "Game in relation to Tsetse" in *Tanganyika Notes and Records*, No. 18, casts doubt on the efficacy of the shooting campaign in Southern Rhodesia. Unfortunately I have never been able to visit the reclamation area, but as great an authority as Swynnerton did so not long before his death. He told me that he had no doubt that Mr. Jack, the then Chief Entomologist of Southern Rhodesia, had succeeded. It must be remembered that the tsetse involved is a single species—*Glossina morsitans*—and that the country, I understand, is not densely bushed. Whether the method of "shooting" would succeed against other species such as *G. pallidipes* and *G. swynnertoni* which live in more densely bushed country has yet to be proved; Mr. Chorley who is now in charge of the Southern Rhodesian work was careful not to commit himself on this point when discussing the question recently with Mr. Potts, Senior Entomologist of the Department of Tsetse Research. It should be stressed that it is not a question of killing off the last animal which would be extremely expensive, but the game is reduced to the point at which the tsetse cannot find food sufficiently frequently to live; naturally the thicker the country the more difficult it is to deal with the game. I hope that the Department of Tsetse Research will very shortly be in a position to carry out its long postponed experiments under East African conditions and with other species of tsetse besides *G. morsitans*. It must be accepted that the South Rhodesian work has, in general, been successful against *G. morsitans* under the conditions ruling in that country; against other species of tsetse and under different conditions the method of shooting must still be tested.

Mr. Rushby then develops his argument on the lines that even if all game is absent—for example, if shooting succeeded—tsetse may still be present. He quotes areas—one of them is Dar es Salaam—in which he alleges there is now no game, yet tsetse fly remain. From the hunter's point of view there is probably very little game indeed close to Dar es Salaam, but from the tsetse's point of view there is in fact "game" and therefore food. In 1941, Mr. Lloyd of the Tsetse Department carried out a survey of the area within a radius of ten miles of the General Post Office. He wrote:

> " . . . there are traces of pig everywhere where thicket is found. . . . hippos occur in the swamp to the east of the Dar es Salaam harbour creek."

It must be recalled that the tsetse requires a full feed only every three days. Furthermore, it is equipped with good powers of sight and is also able to smell and thus is well fitted to make contact with its food even when the latter seems

scarce. Another instance cited is that of islands on Lake Tanganyika without game or people but where there are tsetse. I do not know which islands Mr. Rushby has in mind but such a one is Kambula island just opposite the port of Mpulungu which must be known to many readers. Here the particular tsetse is *G. palpalis martinii* (the water-side tsetse of Lake Tanganyika) which unlike *G. morsitans* is a feeder on reptilian blood, and, of course, finds a plentiful supply of food in the blood of varanid lizards and crocodiles, and in water-haunting birds.

Mr. Rushby then attempts to show that the food of the tsetse may not be blood and refers to Mr. Davidson's work, of some twelve or thirteen years' ago, on feeding tsetse solely on the latex of plants. Soon after the account of Mr. Davidson's work appeared in the Press the Tsetse Department carried out experiments in order to try and confirm his findings. Swynnerton gives an account of the experiments on page 196 of the "Tsetse Flies of East Africa". This "Nandi" hare of latex-feeding is started at regular intervals and Swynnerton's account is given in full in order to try to put the elusive animal in the bag once and for all :

> "It has long been known that certain flagellates—*Leptomonas* (*Phytomonas*)—that are closely related to trypanosomes are found in the milky juices of numerous species of plants and that part of their life is spent in plant-sucking insects, such as plant-bugs. It was, however, claimed recently by Mr. Davidson, of Natal, that the tsetse fly *G. pallidipes* will feed on *Euphorbia tirucalli* and other latex-bearing plants. As this was opposed to previous observation and to the finding [by Wigglesworth] that the digestive enzymes of tsetse flies are adapted to the digestion of blood but not of plant juices, it became advisable to repeat the Natal experiment. Potts and Herbert Lloyd experimented independently, the former on *G. swynnertoni* and *G. pallidipes*, the latter (closely following Mr. Davidson's technique, particulars of which the latter kindly supplied to me) on *G. morsitans*. Neither was able to confirm the claim. Two flies in all in these experiments, both *G. morsitans*, probed the specially warmed plant—as they will probe any warm surface—but these at once withdrew their proboscides and spent some time in cleaning them. All the remainder refused to probe. All the flies used were hungry and all at once fed on man after refusing the plant persistently. I looked for indirect evidence but was unable to find that tsetses were any more present, or in 'feeding-ground' proportions, in localities with much *Euphorbia tirucalli* or *E. matabelense* than in those that lacked them completely. Mr. Davidson's result would appear to have been merely that obtained by Fuller and Mossop when they induced captive tsetses to probe specially warmed grapes that they had refused to probe when at air temperatures(1). Carpenter(2) on the strength of objects found by him in the gut and proboscides of *G. palpalis* concluded that tsetses do sometimes suck water or plant tissues. Otherwise, the tsetse, on the large mass of the evidence available to date, remains purely a blood-predator.

(b) As regards the utilization of water, 'preliminary experiments showed that *G. swynnertoni* and *G. pallidipes*, allowed access to water, damp earth (saturated) and 'Manyara' (*Euphorbia tirucalli*), survived captivity no longer than flies denied access to any kind of moisture. Flies kept with water available under rat-skin, although they pierced the skin to such an extent that its surface was covered with drops of water which had oozed through the openings so made, were apparently unable to use the water' (W. H. Potts). Lester and Lloyd found in Nigeria that large feeds of water were fatal([3])."

To the best of my knowledge Mr. Davidson's work was never published in any scientific journal. In all the years since, no evidence as far as is known by the department, has ever been produced by any tsetse-worker in any country to support the thesis. On the contrary back in 1934, Mr. R. H. T. P. Harris, the well known South African tsetse-worker and inventor of the Harris trap, carried out a full investigation in collaboration with Mr. Whitnall and published the findings, which were also negative, in a paper "The Vegetable Diet Theory of *Glossina pallidipes*"([4]). The authors refer to "a paper recently read [by Mr. Davidson] before a meeting of the Durban Members of the Royal Society of Tropical Medicine and Hygiene", and sum up as follows (page 111):

"(6) Latex, a storage product of certain plants, is contained in lactiferous tubes in the xylem and the only manner in which the tsetse could feed upon it would be by thrusting its proboscis into a containing vessel.

(7) In the experiments here set forth it is clear that the flies are totally incapable of piercing the plant tissues, and if given opportunity to feed on latex as it occurs in nature, they soon die and no reproduction takes place.

(8) Further, the latex has an undoubtedly toxic effect upon those flies which have been artificially induced to partake of it through a membrane."

The evidence against tsetse feeding on any substance other than blood is therefore overwhelming.

In the latter part of his article Mr. Rushby discusses the spread of tsetse. Enormous advances have in fact taken place in Tanganyika through tsetse advancing into country bearing bush favourable to the pest in every way. But Mr. Rushby rightly points out that there is another side of the picture—the springing up of bush in country which did not carry bush before, and the spread of tsetse into this new country. No doubt the browsing of the game does have some effect in keeping the bush down, but I believe a much more important factor in the suppression of young trees and shrubs is the cessation of annual grass fires. The natural fires have stopped in many places either owing to the eating off of the grass by the valuable increase in the herds of cattle which the Pax Britannica and the efforts of the Veterinary Department have made possible, or to deliberate fire prevention measures by Government

and private individuals. The former effect is excellently demonstrated in certain limited areas at Shinyanga. It could be controlled perhaps by subjecting the area to fire every four years. Certainly pessimism is out of place. England was forest at one time and the whole aspect of the country has been changed by man, yet the fertility of the soil has been maintained over hundreds of years and we see an unsurpassed standard of farming. What is required in East Africa is research and yet more research to show how this can be achieved under tropical conditions.

REFERENCES

(1) Fuller, C. and Mossop, M. C., 1929: "Entomological Notes on *Glossina pallidipes*." *Sci. Bull. Dep. Agric.* S. Afr., 67.

(2) Carpenter, G. D. H., 1913: "Second Report on the Bionomics of *Glossina fusciper* (*palpalis*) of Uganda". Rep. Sleeping Sickness *Comm. Roy. Soc.* 14: 28-29.

(3) Lester, H. M. O. and Lloyd, Ll., 1928: "Notes on the process of digestion in tsetse flies." *Bull. Ent. Res.*, 19.

(4) Harris, R. H. T. P. and Whitnall, A. B. M., 1934: "The Vegetable Diet Theory of *Glossina pallidipes*." *Onderstepoort Jnl. Vet. Sci. and Animal Indust.*, 2, 101.

Shinyanga,

12th May 1945

Biological Brevities

(Continued from page 58, T.N.R. No. 17, June 1944)

By W. Victor Harris

10.—Phrynus, the Whip-Scorpion

PHRYNE was a notorious beauty of Ancient Greece. The only clue I can find as to what Lamarck may have had in his mind in associating with her so repulsive a creature as the whip-scorpion, comes in a quotation from Propertius,

"Quae deletas potuit componere Thebes,
Phryne, tam multis facta beata viris."

Phryne could rebuild Thebes with her spoils. The whip-scorpion looks to be an equally successful predator.

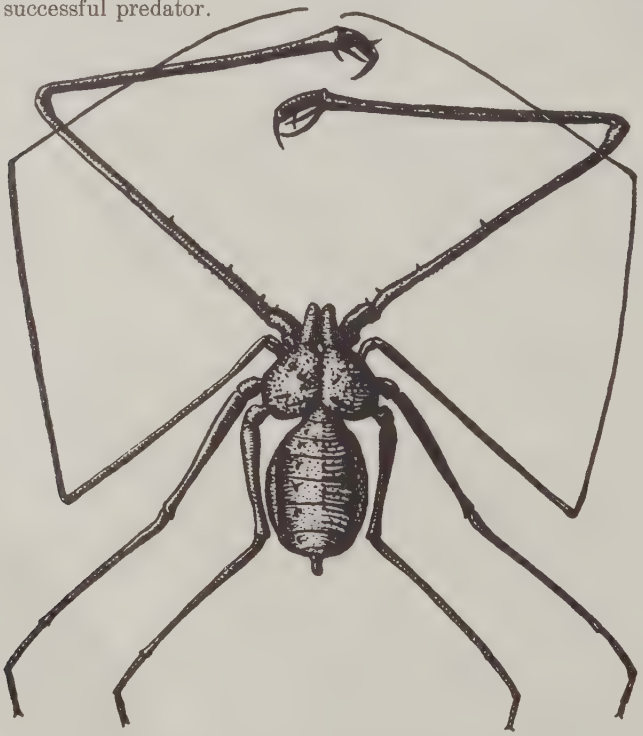


Fig. 1.—The whip-scorpion, *Phrynus* (natural size).

Whip-scorpions come between the true scorpions and the spiders in the ordering of animals. Despite their looks they are not poisonous. Their prey consists in the main of small insects which they find in the dark caves, cess pits and other secluded places that they haunt. Like other Arachnids they have four pairs of legs. Three pairs only are used for walking, and the first pair have become delicate whip-like feelers which are stretched out in front as are the antennae of insects. The long pincer-ended claws are built for lighter work than those of the true scorpions.

Odd specimens of whip-scorpions have been reported from botanical gardens in temperate countries, whither they have been accidentally carried, but their natural habitat is the tropics. Those of Asia and Tropical America have short slender tails, but the African whip-scorpions are tailless.

11.—Insect Bulldozers

In our cattle country, much of the animal droppings is quickly removed by oval and very convex beetles of sombre colouring. These are the *Coprinae*, the scarabs or dung-rollers. They have developed heads well adapted to their work, either as strongly toothed hoes like the common scarab shown on the left in Fig. 2, or in the bulldozer manner as shown by the rather rare example on the right. The low build and short powerful legs of these beetles gives them great power in proportion to their size for pushing and scooping.

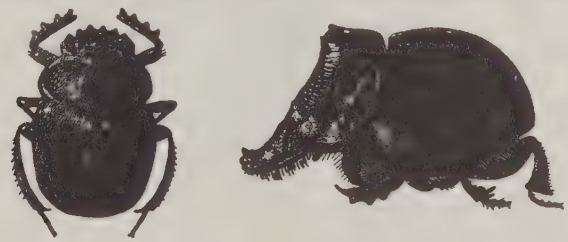


Fig. 2.—Two Scarab beetles (natural size).

They arrange the manure into spherical or sausage-like lumps, which they then roll away to their underground chambers, as food supplies for their young. Male and female scarabs are often found together rolling home the fruits of the day's labour. When the ball is safely stowed away, the female lays an egg on it, seals up the entrance to the chamber and goes on her way. In a few species, however, there are indications of a maternal instinct rare among solitary insects, as the female stays around and tends the young brood after they have hatched out from the eggs.

The ancient Egyptians were so struck by the ball-rolling habits of their common scarab, and by the fact that each year they suddenly appeared as if from nowhere just before the Nile floods, that they adopted them as a symbol of the re-birth of Life each Spring and added them to their collection of sacred beasts.

12.—Cockroaches

Conspicuously bad habits in one section of a nation make other people regard all the nation as undesirable, characterizing the whole with the undesirable features of a part. So it is with cockroaches. Yet among the numerous African members of the family there are many that are curious, some even prettily coloured, and most are harmless. The house-haunting kinds are such a pest, however, that it is understandable why most people "write off" all cockroaches as undesirable.

The ancients called them *lucifuga*, the light-shunners. The "black beetle" of English basements was introduced from the East in the dim past, while the smaller "shiner" or "steam fly" is a more recent arrival from Europe. So unpopular is the cockroach that it is recorded that it had four common names in Germany—"Schwaben" in the north, "Preussen" in the south, "Russen" in the east and "Franzosen" in the west.

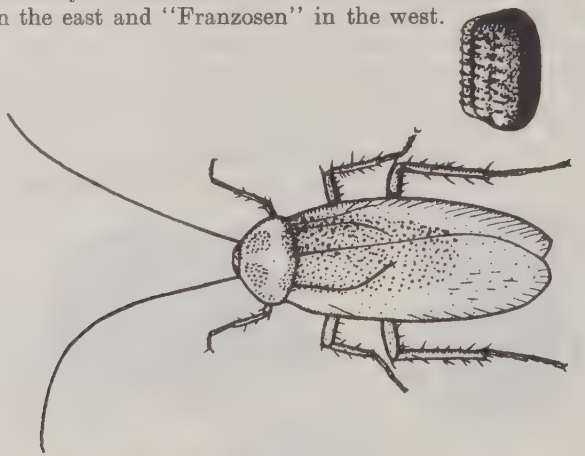


Fig. 3.—The Australian Cockroach, and its egg-case (natural size).

The two large domestic cockroaches of Tanganyika are both introductions, one from America, the other from Australia. They are found in ports throughout the world, and in warm countries move inland. There appears to have been a considerable increase in their numbers here during the last few years. *Periplanetta australiae* is shown in Fig. 3. It is paler in colour than *P. americana*, and the two dark patches on the thorax, or neck-shield, are more distinct and separate.

Cockroaches are creatures of the dark, damp and dirt. They do not, as a rule, move far from where they were born. The female lays her eggs neatly packed up in plastic boxes, which are resistant to ordinary insecticides. These egg-cases are glued away in the most secluded cracks the female can find. Since the eggs take some time to lay, females can often be caught going about with an incomplete egg-case protruding from the abdomen. There are few

articles of vegetable origin that cockroaches will not damage, from corks in bottles to the bindings of books, and such articles of animal origin as fur coats and Sunday suits. But these bad habits do not apply to the rural cockroaches, which are really worth a second thought.

NOTES

Bagamoyo, 1883—1945

By Robert Ollendorff

I RECENTLY visited the Holy Ghost Mission in Bagamoyo and having been permitted to look through their collection of books and documents of the history of this Territory, dating back to 1863, I found most interesting records of the old days. The founder of the Mission Station, Father Horner, died in 1883 and as a memorial to him the Father Superior gave the following description of Bagamoyo (*Bulletin General of the Holy Ghost Fathers*, 1883):

"It was, one remembers, in 1869, six years after the arrival of the Fathers Horner and Baur in Zanzibar, that the station Notre Dame de Bagamoyo was established. But in these twelve years, what transformations! Then, around the huts of Bagamoyo spread an immense bush where wild animals chased each other. Now, even though there are no palaces and boulevards, there is not a single street that does not overflow with mats and merchandise, with herds of animals, and men of all colours, languages and tribes. Small lanes criss-cross between countless huts built with absolute contempt for straight lines and right angles. The sense of smell of him who penetrates this maze is assailed by an indescribable perfume which pervades everything: drying fish from the fish market, burning incense, essence of cloves, rancid butter, rose water, and the sweat of men, an all-African odour. But between those huts, relics of another age, the last ten years saw beautiful Arab houses come to life, and the rich stores of Mohammedan Indians, Buddhists and Banyans from Cutch and Bombay. And Bagamoyo had become the most important market on this coast, second only to Zanzibar. Here arrive ivory, gum copal, simsim, raffia and all the other products of this region. In a good season, seven, eight, ten thousand strangers come with the caravans in a single week. And on the 6th of November last year (1882) one could watch the arrival of a famous merchant traveller, Tippoo Tib by name, who came from the interior with 70,000 lbs. of elephant tusks and 2,000 porters. Strangers rarely stay long in Bagamoyo, but some do, so that the population now holds representatives of every up-country tribe, and with them are Arabs from the Persian Gulf, Indians, Baluchis and Goans. The permanent population is estimated at 10,000 souls. Sewa, a wealthy

Indian, has bought us a nice plot in the township of Bagamoyo for a hospital and rest camp for sick porters . . . .''

And now, Bagamoyo in 1945! A strange fascination emanates from this dead world whose shell is still partly inhabited by the young and living. A crumbling down of a history, a culture, overrun and destroyed. Not more than fifty to sixty years part us from the days when Bagamoyo was at the zenith of its importance; but historically they take us back centuries, into a world of feudalism, into the magic of the *Arabian Nights*! Architecture and elaborate decoration were the only way, then, for an artist's self-expression or a rich man's pride. In the iron-work window screens, the brass-studded carved doors and door frames, the ornament shows finest craftsmanship and artistic imagination. One aches to preserve all this beauty, to protect it against corrosion, rot and abuse; but time will do its deadly work before we appreciate the true historic significance of this period.

The Holy Ghost Mission, the first Roman Catholic Mission on African terra firma in modern times, was founded after exciting adventure and exploration, as hostel, haven and help to every European who attempted to penetrate the interior. To-day this Mission and an attached priest seminary stands quietly under coconut palms and, though still hospitable and helpful, a stranger but rarely finds his way to it. The Customs House, dull and oversized, stands by the shore, flanked by palatial quarters, the white splendour of Wissmann's Government House, now the District Office; then comes the Arab jail, bizarre and strong; and under casuarina trees an old German cemetery where soldiers who fought Bushiri and Bwana Heri have their graves.

But life continues: In the lovely caravanserai where Emin Pasha nearly broke his neck, a teacher's school has found its home. A rice and oil mill runs a noisy competition with braying asses. In the morning the fishermen's fleet of outriggers sails against the rising sun; there are thousands of coconut palms to be tended, fields to be cultivated. There is a busy bazaar, salt from the sea and wild Mavia labourers from Portuguese East Africa to be shipped round the mouths of the Ruvu and Pangani rivers to sisal estates; there is the jahazi and dhow traffic from Zanzibar, announced by the eerie sound of conch shells.

Kaole, three miles from Bagamoyo, is a beautiful place, where an upper Baluchi village looks down into the lower one with its huts bedded in palm trees, the sea and boats lying at rest. There, too, Shirazi ruins and graves await further excavation and description. And finally, there are the coral reefs with their exciting wonders of marine life; and when one is fishing or basking in the sun, a faint fragrance of cloves drifts over from Zanzibar and mixes with the ''all-African odour'' in town; those are lasting . . .

Supplementary Note on Stone Structures in East Africa

By C. Gillman

I AM much obliged to several readers of my "Annotated List of Ancient and Modern Indigenous Stone Structures in Eastern Africa" (this Journal, No. 17, 1944, pages 44-55) for the following additional information they have kindly supplied; and I take this opportunity to add also a few further notes which have come to light accidentally in the course of research in other directions.

Nkila-ya-Mva's Wall at Usule.—First and foremost I must apologize for having omitted from my first list the very interesting example of a substantial stone wall in Usule at the north-east corner of the Tinde hills in the Shinyanga District of the Lake Province. Mr. C. M. Coke writes about this wall thus:

> "It was built by the great-grandfather of the present Chief of Usule (? Kajalla III) as protection against Mirambo's raids—after Usule had once been caught unawares and overrun by Mirambo. Kajalla's ancestor had, if I remember, fought off a raiding party of Mirambo's and not been conquered: whence he was called 'Nkila-ya-Mva', that is 'the Tail of the Dog'—which the lion leaves and does not eat. Their defensive position was the steep gully in the northern Tinde hills across the mouth of which this wall was built. It is called Iwe (? connection with Jiwe in Kisukuma) and is the traditional 'homestead' now of the Chief when his ceremonial drums are beaten at festivals. All these notes are from memory and should be checked up for accuracy by some one better skilled than I am."

I had myself visited this site in May 1924, when I made the following entry in my *safari* diary:

> (Coming from Tinde) "a rapid descent . . . brought us in a few minutes to the village of Kasigo, the Sultan of Usule . . . The great stone wall substantially erected by Nkiliwamba, the present Sultan's father, against the raiding hordes of the great Wanyamwezi king Mirambo, still stands almost intact, surrounding a village hidden away among the rocks and boulders of the main ridge and a lateral spur."

A photograph taken by Mr. Coke shows that the dry masonry of this wall is exceptionally well and carefully laid, the material consisting mostly of thick slabs, the product of desquamation of the great granite tors through daily solar heating and nightly cooling.

The first and oldest map which shows the "Ikuru of Sultan Kirawambua" is one depicting the route of Baron L. Fischer from Tabora to Lake Nyanza in 1892 (*Mitt. D. Sch.*, Vol. V, 1892, map XI); the section from Karitu to Mantine, including Usule, being one that had not been trodden before by a European. Extracts from the Baron's diary (*ibid*, page 256) do not, however, mention the wall.

Merere's Wall at Utengule.—It appears that the first Europeans to visit this walled town were the Moravian Missionaries, A. Merensky and Nauhaus, in January 1892, and the first description—with main emphasis on an indescribable quagmire of mud and manure—is contained on pages 237 and 240/41 of Merensky's book *Deutsche Arbeit am Nyasa*, Berlin, 1894. According to him "Utengule" is a general term meaning "consolation", so that one might imagine the old potentates looking upon their safe fortifications as a sort of "*sans souci*"!

Masai Walls.—Mr. J. W. T. Allen mentions further such walls on the Tanga-Moa coast from Kwale, Ndumi and, probably, on Boma Peninsula, especially at Boma la Ndani.

On the Anti-Masai Walls in North Mara I have recently unearthed the following interesting remarks by Hauptmann Schlobach who led an expedition from Mwanza to Shirati in 1898 (*D.K.B.*, 1899, pages 124-31). He writes:

> "The rock-villages of the Wakenya [? Kuria—C.G.] are astonishingly well fortified on high and steeply rising granite kopjes. All gaps between the blocks of rock are closed with cyclopic masonry. The small round huts are placed close together and look glued to the naked boulders. North of the Mara River, towards Ugaia, this is the customary type of village, a proof that up to the present war-like conditions have prevailed in these regions . . . " (page 128). "On the 2nd August the expedition faced one of these fortresses of surprising dimensions. This Boma Kiboroswa [shown on the accompanying map about ten kilometres west of the present District Headquarters of Tarime—C.G.], situated on a ridge some 50 metres high between two small, running streams, had a wall about 600 metres long, 3 metres high, and 2·5 metres thick, and superimposed by barricades of thorn."

This Boma, held by Wasweta warriors, was stormed and the walls levelled to the ground.

Dr. F. Dixey, who has recently travelled extensively in the Northern Frontier Province of Kenya, sends the following observations:

> "The Wagogo wells referred to in paragraph 5, page 47, recall similar things common in the Northern Frontier District; they also were constructe

by former people, often in dense clusters, 22 to 24 inches in diameter and up to 60 feet in depth. Certain less regular wells followed a zig-zag course downwards along weathered joints in the solid rocks."

"With reference to paragraph 9 (e) of page 53, the stone circles referred to occur over a large part of the Northern Frontier District of Kenya; they are associated also with stone mounds of similar or larger size, possibly 40 feet in diameter and 10 to 12 feet high. They are common on the volcanic plains and near lava scarps, or wherever rock rubble is abundantly present. The stones usually range from 4 to 9 inches across, i.e. those that could easily be carried by hand."

"As regards paragraph 10, Hobley is probably referring to certain old tanks much eroded but still in use along the Italian Border east of Wajir."

Extracts from an official report by Dr. Dixey, however, makes it clear that these tanks are excavated in clay and are, thus, not stone structures.

Finally, I have the following communication from Mr. D. H. A. Bell on the subject of the CAIRNS IN UFIPA, written in November 1944 :

"I have not read Baines' account but there is another in *Aux Rives du Tanganyika*, by Mgr. Lechaptois. In Chifipa such a cairn is called 'Ifingwa'. Lechaptois was told that these stones were heaped to witness against a liar and this is the same explanation that I was given. As liars are not held in particular disrepute by African society the Bishop doubted the literal truth of this explanation and suggested that these cairns commemorated some blasphemy, not against the spirits but against the Supreme Being 'Lesa'. There being no word for 'blasphemy" in Chifipa 'lie' might easily be used instead. The stones heaped as a cairn would symbolize the death by stoning that the blasphemer deserved."

This may be a valid explanation, but I think these cairns also originate in anti-social lies. There is one in the Kanda hills close to Sumbawanga which was made because of a man who said that a swarm of locusts had alighted in the *shambas* there. Everybody turned out with sticks to drive them away but, on arrival, found that it was only a leg-pull. So there and then they heaped stones to form an "ifingwa".

Such a cairn, as well as certain rivers, is also an "akawango" (plural "utuwango"). A pregnant woman may not pass such places on foot but must be carried; if she is not, she will abort.

The Name "Dar es Salaam"

By J. W. T. Allen

IT IS SURPRISING that the derivation from Bandar-ulSalaam should for so long have been accepted without question (cf. *T.N.R.*, No. 3, page 117). Professor Jespersen,* whose opinion should not lightly be disregarded, shows that, with few exceptions nearly all of which are easily explained, words which undergo violent shortenings in the speech of children retain the end; but those which are shortened by adults retain the beginning. The exceptions are mainly normal assimilation of a light consonant as in Baccy and Taters or as in 'cello when the other half of the word already has a meaning.

Now the Arabic word for a harbour is Bándar, not Bandár or Bandaar. It is found all over the map in the singular as in Bandar Abbas and in the plural as on the Banadir Coast. I can find no parallel for its contraction to Dar, though, as we should expect, in some languages it is shortened to Band or Bund. Band-esSalaam or Bandr-esSalaam would have been easy. It appears that to account for its contraction to Dar we must assume that the town was named by children, improbable; or that Arabic Bándar became Swahili Bandári before the name was formed, in which case it ought to be (Ban)Dari-ya-Salaam, or that it is like 'cello and that there is a common word Band, which is not known, and no common word Dar.

But not only is there a common word Dar but this word is used in a very common phrase Dar-Ulslam.

Dar (Swahili Dari) means a large house or a country, and using this word I have three suggestions for the origin of the name. The last is not, I think, meant to be taken seriously, but it is worth recording. I regret that I cannot acknowledge my source; I have forgotten the name of the Swahili who gave it to me:

(a) Moslem legists divide the whole world into Dar-ulHarb, the land of warfare, and Dar-ulIslam, the land of peace, meaning the countries where the edicts of Islam do not run and the countries under Moslem rule. Is it not likely that the early traders up country in Dar-ulHarb would refer to the settled coast strip at Dar-ulSalaam or Dar-ulIslaam? The pronunciation DarusSalaam is quite natural. They may, too, have thought of the literal meaning, the Abode of Peace much as they thought of Baga-moyo as the place where the weary traveller could rest.

(b) Mzizima. I do not know if this does mean Mji mzima, but even if it does not it is possible that some Arab thought it did and translated it.

* "Language, its Nature, Development and Origin", IX, 7.

(c) The big house built on the front by Said Bargash is Dar-ulSalaam. It was built as a place of retreat for awkward ladies from Zanzibar. According to this interpretation the Dar is on the mainland, but the Salaam is in Zanzibar.

A further note on Chimpanzees in the Kigoma District

TO THE first-hand European evidence listed by Mr. R. E. Moreau, this Journal, No. 14, 1942, pages 53/54, the following observations by Dr. R. B. McConnell of the Tanganyika Territory Geological Survey should be added. They were made in the course of geological field work in the Kungwe-Ubende mountain district in 1944. Chimpanzees were actually seen on Lunguma Mountain, thirty kilometres south-east of Kungwe (5,500 feet altitude, 30° E., 6°15′ S.); and in the fringing forest remnants of the upper Kampisa Valley (4,500-4,000 feet), some five kilometres west of Lunguma. Nests were observed throughout the Mahali mountains and on all high ridges westwards to the Lake; on Mount Kungwe itself, and on the northern slopes of Kapalagulu Mountain, twelve kilometres north of Kakungu Trig. Point (5,000 feet, 30° E., 5°52′ S.).—Editor, *T.N.R.*

BOOK REVIEW

"*Origin of Some East African Food Plants*", by P. J. GREENWAY.

In 1909, Dr. F. Stuhlmann, the first Director of the Amani Agricultural Research Institute, had published the results of many years of investigation regarding the introduction into East Africa and the economic values of food plants and domesticated animals. This bulky tome of over nine hundred pages (*Beitraege zur Kulturgeschichte von Ostafrika*", Berlin, 1909) is not easily accessible and more recent research has, no doubt, made it out of date in many respects. Our gratitude is, therefore, due to Mr. P. J. GREENWAY, the Systematic Botanist of Amani, for having compiled this most useful paper which is appearing serially in Vol. X (1944/45) of the *East African Agricultural Journal* and can be obtained as a separate book from the Government Printer, Nairobi, or from Amani. With his wide knowledge of the subject, and with the well-stocked Amani Library at his elbow, the author has managed to condense a vast amount of historically, geographically and economically interesting matter into thirty closely-printed pages.

After a short introduction he lists twenty-one food plants of African origin and one hundred and six introduced from other continents, grouping his material under the following headings: Roots and Tubers; Leaves, Fruits; Fruits used as Vegetables; Pulses; Grains; Oil Seeds; Spices and Condiments; and Beverage Plants. His results regarding the origin of all these plants are also given in a series of well arranged tables; and a useful Bibliography concludes a careful and painstaking little work which can be highly recommended to all interested in the subject.—C.G., *Dar es Salaam, February 1945.*