

Eggs included in the above list, of whose taking I can find no previous printed record, are *Francolinus mulemæ*, *Lybius bidentatus æquatorialis*, *Lanius mackinnoni*, *Poliospiza angolensis somereni*, *Phyllastrephus albigularis*, *Chalcomitra angolensis*, *Cisticola lateralis*.

The 126 species here recorded constitute about one-fifth of the birds which in all probability breed within the limits of the Uganda Protectorate.

LUMBWA CAVES

AN INVESTIGATION INTO CERTAIN MINERAL DEPOSITS OBTAINED THEREFROM

BY C. W. HOBLEY, C.M.G.

ALSO NOTE BY V. H. KIRKHAM AND W. C. BIRCH

Early in 1918, in response to an inquiry, the District Commissioner at Kericho sent down some specimens of a soft rock, which the natives excavate from caves in that district and use as food for their live-stock.

The bulk of the specimens consisted of grey, powdery ash and a light volcanic tuff, and reminded one of certain rocks from other parts of the world. Chemical tests confirmed this, and one specimen yielded as much as 13 per cent. of tricalcic phosphate. This percentage compares badly with phosphate rocks in other parts of the world (but of quite different origin) which carry phosphate; but it was enough to warrant further investigation, and the region was accordingly visited by the Government Analyst and myself in March 1918, and specimens taken from each of the caves visited.

We left Lumbwa, and marched to Kericho Government Station. The following day, leaving our caravan there, we first explored the Bagau Cave, which is about seven and a half miles to the north of the station. This cave occurs behind a small waterfall in the steep valley of a small stream which runs towards the Nyando River. The cave is of artificial origin, and made for the purpose of extracting a layer of soft rock which lies between two beds of lava. We penetrated

about a hundred yards, and collected specimens. This cave is in a most dangerous condition, and numerous rock-falls from the roof have recently occurred.

The following day we left Kericho and marched south to Gitoi Camp, where we were met by the District Commissioner. This camp is on a beautiful site on a bend of the Jamjee River. In the afternoon we explored Gitoi Cave, which lies about a mile to the west. The scenery at the entrance to this cave is very striking; there is a great step, about sixty feet deep, in the valley of the stream, due to the cutting back of a sheet of phonolite lava. In flood-time the river runs over this ledge, forming a fine waterfall. A few hundred yards back from the edge of this ledge, to the east, the water of the river, in the dry weather, all disappears into a fissure in the lava and reappears near the base of the cliff. We penetrated the cave for a distance of a little over one hundred yards, and saw where the natives excavated the salt rock. It was very wet and slimy inside.

This cave is also entirely artificial, and the workings were formerly much more extensive than at present. Owing probably to an earth-tremor, and to the fact that extensive excavation had been carried on and inadequate supports had been left, the lava sheet settled and blocked a great portion of the workings.

At the same time a crack was formed, through which the water of the river descended into the cave, eventually emerging near the foot of the cliff. This settlement is said to have occurred about thirty years ago, but before that the workings were very extensive.

Our next halt was on the Kiptiget River. We explored Kipchobos Cave, which was near our camp. This again occurs in the valley of a small stream, and the entrance is under a small waterfall. The entrance is very low; but, after crawling for about forty yards, we entered a great hall about seven feet high. From this hall, four distinct passages lead off, and later on they sub-divide again into passages leading in various directions, and of heights varying from four to six feet. We had not time to explore all the ramifications, but penetrated about 160 yards. In one of the passages there were

many bats ; and at one spot, over one hundred yards from the mouth of the cave, a number of mosquitos were seen.

The roof of the cave is very sound and safe, but the air was very foul in some of the passages, and our lamps grew dim. The specimens from this cave gave good results.

The next we visited was called Kiptoit. We found, however, that the mouth had been blocked by fallen rocks. The sequence of rocks was the same as at the ones previously visited, and the entrance was under a small waterfall.

Having heard of an extensive cave to the east of the cart road, we determined to visit the spot. The name of this cave is Kibroise, and it is on a small stream called Chemunguet. As usual, the entrance is behind a small waterfall, and is very low, but, once inside, it becomes higher. We penetrated to a distance of about 180 yards, and some of the passages went in still farther. There were two large pools in the main passage, through which we had to wade for some distance ; they were about three feet deep.

Near the end of the workings, we found from twenty to thirty young men (Lumbwa) busily excavating the soft rock they call *ngenda*. The deposit found in this cave is stated to be specially suited for cattle, and large numbers of cattle were munching it with avidity at long wooden troughs, placed in a clearing about one hundred yards from the cave, at the top of the hill. A number of natives were working away outside at the entrance to the cave, crushing this soft rock with stones. The rock is undoubtedly very attractive to domestic animals ; for when we approached these troughs, my mule, who had never been to this district before, whinnied and rushed to one of the troughs and eagerly began to munch the powdered rock ; the native goats were also nibbling at the rock exposures in the vicinity of the caves.

The natives stated that, if possible, they brought their cattle to this spot about three times a month. We inquired if the caves were owned by any person or group ; but were told that they were free to any members of the tribe who desired to dig the rock for his stock. No person outside the tribe is allowed to dig. As each person requiring it digs for the use of his own stock, the rock has no quotable value.

The thickness of the deposit in this cave was greater than some of the others, and reached a maximum of about seven feet thick. The usual lava beds occur above the rock, whilst below is a rhyolite, sometimes amygdaloidal. Occasional dykes of harder rock traversed the cave, and pillars of rock had been left at intervals as roof-supports. The roof was sound, and rock-falls appeared to be rare. The natives work in the cave by the light of bundles of twigs, which give off comparatively little smoke.

This was the biggest cave visited, and appeared to be the one most worked. The field tests did not, however, give such good results of phosphate as some of the others. The digging is done by means of rude iron picks—the pick blade being set in a wooden club (see Fig. 1).

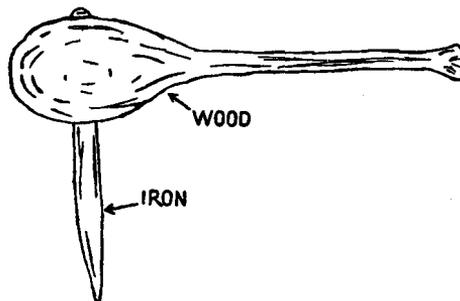


FIG. 1.—Rough pick used by Lumbwa in the caves.

The quarried material is transported to the mouth of the cave in small wooden troughs of light wood, which are slid along the ground (see Fig. 2).



FIG. 2.—Wooden trough used for conveyance of salt earth in caves, Lumbwa.

All the work inside the cave is done by men. Streams of women carry away the rock in wicker creels, carried on the

back. It is thus distributed all over the country to the various villages, and crushed and placed in wooden troughs for the stock to eat. The natives informed us that the rock from the various caves differed in quality. The majority was only fit for goats, and if given to cattle it made them thin. The rock near Kibroise, it was alleged, was especially good for cattle, and they brought cattle from long distances to it.

On our return journey, we camped on the Jamjee River, which is about eleven and a half miles south of Kericho. I panned the river sand there, but only found the usual residue of iron, sand, and splinters of a hard black mineral—probably magnetite. We revisited Gitoi Cave, and examined rocks in the vicinity. The Lumbwa guides gave us information of three other caves, which, unfortunately, we had no time to visit.

It is a matter of great regret that the results of the examination turn out to be very discouraging from the point of view of the discovery of a source for 'phosphate' for the benefit of the agriculture of this country. The percentage of tricalcic phosphate turned out to be most variable, and in no case did the results come up to the percentage in the original specimen.

It is therefore clear that the beneficial effect, which the Lumbwa people declare it has upon their live-stock, is not due to the small percentage of phosphate. The avidity with which animals devour it is, however, a most striking phenomenon, as it is not of saline nature; the Lumbwa all declare that it greatly improves the condition of the cattle. The saline mud from most native salt-licks acts as a vermifuge, owing to its purgative effect. Careful inquiries were, however, made on this point, and the stock-owners all declared that it had no appreciable laxative action.

The chemical investigation, however, discloses the fact that it has a considerable neutralising effect on hydrochloric acid, and it is therefore suggested by the Analyst that its alleged benefit may come from its effect as an anti-acid. It would be interesting if some experiments could be carried out in the veterinary laboratory on this point.

THE METHOD OF OCCURRENCE

Lumbwa country consists of a gently rolling plateau, generally sloping westwards towards the Kisii Ridge and southwards towards the Sotik Plains. When one comes to march over it, however, it is found to be dissected by numerous deep valleys, the majority of which drain away to the Sondu River and so into Lake Victoria. The whole area is composed of volcanic rocks of no great geological age. The soil is deep red and often of great depth, and, generally speaking, the rocks next below the soil are beds of soft, yellowish-brown ash, fine in grain and uniform in texture. Immediately below that, one often finds a rhyolite, the cavities of which contain zeolites. Below that again is a sheet of phonolite, which appears to be continuous from the north to the south of the district in the region of the cart road. Near Bagau Cave it is probably over one hundred feet thick, and at Gitoi it appears to be about fifty feet. Its character is very uniform throughout.

Below the phonolite lies the bed of ash and tuff, which is excavated by the Lumbwa as either a condiment or medicine for their live-stock. It varies in thickness from four feet to ten feet. Its usual thickness is from four feet to six feet. It varies in hardness, and the harder portions are left as pillars to support the workings described in the itinerary. Its persistence appears to be a remarkable fact, for its northernmost outcrop occurs at Bagau Cave on the Kipgues River, in lat. S. $0^{\circ} 86'$, and it was again identified just north of the Kipsonoi River in lat. S. $0^{\circ} 38'$. It appears to cover, without intermission, an area of about 160 square miles, and possibly more.

Below this ash bed another sheet of vesicular rhyolite occurs, much harder in character than the upper bed of that rock. The thickness of this was not ascertainable during our journey. This volcanic product also appears to run in an uninterrupted fashion from north to south.

The question arises as to the origin of this series of volcanic rocks, and it is to be regretted that time did not permit of detailed inquiry into this problem. It is, however, premised that these rocks are the ejecta from a series of volcanic vents

which occur on the southern flank of the Nyando Valley, and commence with the mountain known as Cheblil. There are other hills, which bear the appearance of weathered volcanoes, in the vicinity of what is known as Tugenon Camp; detailed investigation is, however, necessary before a definite statement can be made, and our visit was mainly concerned with the economic possibilities of the deposit worked by the Lumbwa.

As regards the origin of the phosphate, this may be due to the presence of minute crystals of apatite in the tuff. The Analyst's report shows that neither the phonolite above, nor the rhyolite below, contains any appreciable amount of phosphate. No microscopic examination of the tuff has been possible up to date.

The great thickness of the red earth in parts of Lumbwa has been referred to, and it has been suggested that this is due to the eruption of vast quantities of volcanic mud from the same volcanoes which at an earlier date produced the other rocks. No evidence to support this theory was, however, observed, and it is believed to be due to the oxidation of the upper bed of fine-grained yellowish-brown ash, the variability in thickness being dependent on its accessibility to denudation.

The whole of the Lumbwa was, it is believed, clothed at one time by dense forest, and this was probably almost entirely cleared off by a former race of aboriginals, the sites of whose huts can now be discerned, for they had a curious practice of building their dwellings in pits in the surface of the ground. Once this forest was removed, a period of rapid denudation set in, and continued until other growth asserted itself.

Whether the ancestors of the Lumbwa drove these people out is not clear; but since the advent of the Lumbwa occupation considerable areas of secondary forest have sprung up, composed of thorny acacias and such like, and the typical forest-trees such as the olive, podocarpus, &c., which still grow a few miles farther up the slope, are absent in Lumbwa proper: in fact, the boundary marking the extent of the ancient forest clearing can still be seen, and tongues of it still run down into, and have been spared in, some of the valleys, as at Kericho Station, thus showing that the general absence of

the true original forest has nothing to do with altitude or climate, but is due to the intervention of man.

Thanks are accorded to Mr. C. M. Dobbs, District Commissioner, Kericho, for the great assistance he rendered in these investigations.

NOTE ON THE COMPOSITION OF THE ROCK OF THE LUMBWA CAVES

BY V. H. KIRKHAM AND W. COLET BIRCH

Specimens of the soft, earthy rock from the workings of the Lumbwa have shown up to about 13 per cent. phosphate of lime, and it was thought that this constituent was probably the reason for its use.

Subsequent analyses seem to disprove this theory. A sample of the crushed rock, actually taken by the natives, was obtained, and gave the following analysis:—

	Per cent.
Water	13.95
Silica	47.76
Calcium oxide	2.97
Magnesium oxide	1.08
Sodium oxide	4.87
Potassium oxide	2.88
Ferric oxide	4.98
Manganese oxide	0.32
Aluminium oxide	22.03
Phosphoric oxide	0.13
Carbon dioxide	trace
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	100.97

It will be seen the rock consists very largely of a hydrated aluminium silicate, and that the amount of phosphate present is too small to have any importance.

Other samples were tested, as regards their phosphate contents, with the following results :—

	Per cent. Calcium phosphate
1. Gitoi Cave, 13/3/18	5.35
2. Gitoi Cave, inside, 13/3/18	0.56
3. Gitoi Cave, 13/3/18	0.56
4. Gitoi Rock, underneath cave	0.42
5. Gitoi Rock, above cave	0.84
6. Gitoi (sample collected previous to Safari)	0.7
7. Gitoi Cave, deposit selected by natives, 3/3/18	0.28
8. Gitoi, outside cave, 13/3/18	0.24
9. Gitoi (sample in envelope)	2.31
10. Bagau, upper bed in cave	0.3
11. Bagau Cave, upper bed in cave, 12/3/18	0.2
12. Bagau Cave, lower bed in cave, 12/3/18	0.39
13. Kibroise Cave, lower bed below the ngenda rock, 13/3/18	0.2
14. Kibroise Cave, ngenda rock, 15/3/18	0.49
15. Kibroise Cave, upper rock, 15/3/18	0.2
16. Kipchebos Cave, 14/3/18	0.59
17. Kipchebos Cave, lower bed of rock, 14/3/18	0.75
18. Kipchebos Cave, upper bed of rock, 14/3/18	0.3
19. Kipchebos Cave, No. 2 (from envelope)	1.46
20. Chemosit Rock, at bridge, 16/3/18	0.6

It will be observed that the phonolite above the worked deposit, and also the vesicular lava below, contain varying amounts of phosphoric acid, but not in an unusual amount. It is probable that the action of water, charged with carbonic-acid gas, has in times past infiltrated between the phonolite and the vesicular lava (which often appears as a rhyolite) and has effected a decomposition of the latter, and deposited a certain amount of phosphatic cement. The amount of this is very variable, and does not appear to have any economic value.

Cattle and goats showed an unmistakable partiality for the crushed rock in spite of the uninteresting analysis, and

there does not appear to be anything in the material itself which is of value in the direction of supplying elements required in animal metabolism; it may be that its function is that of an anti-acid—*i.e.*, that the animals eat to neutralise excessive acidity of the gastric juice.

An experiment was made to ascertain the power of the material to neutralise a solution of hydrochloric acid of a similar strength to that occurring in the stomach of stock.

One hundred grams of finely powdered material (the sample whose full analysis is given above) were digested with a litre of 0.3 per cent. hydrochloric acid for twenty-four hours, and then filtered. The filtered solution contained 0.9 per cent. solid matter, showing that dilute acids have considerable solvent action on the material. Under the conditions of the experiment, the acid was largely neutralised by the mineral—about 90 per cent. disappearing.

A physiological experiment is necessary to ascertain the precise function of this rock. It may be useful, by mechanical irritation of the bowels, in regulating their action or discouraging intestinal parasites.

THE SOUTH-EAST FACE OF MOUNT KENYA

BY CAPT. G. ST. J. ORDE BROWN, R.A.

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Such exploration as has already been done upon Mount Kenya appears to have been largely confined to the northern and western aspect of the mountain. Mackinder and Gregory both attacked it from those sides, while the more recent Roosevelt Expedition also largely neglected the south-east slope. The following notes are made without claim to scientific value, but in hope that they may be of use to subsequent explorers wishing to investigate the least-known side of this very interesting mountain.

The characteristics of the south-east aspect may be summed