

The Pleistocene Lake Beds of Kabua, Northern Kenya

ABSTRACT

A sequence of fossiliferous, late Quaternary lake beds is well exposed at Kabua near the western shore of Lake Rudolf. The deposits are banked against Miocene volcanic rocks of the Lothidok hills and indicate the late Pleistocene extent of the lake. These lacustrine sediments have yielded numerous mollusca, various artifacts, and fossilized mammals. The mammals resemble species now absent from the region, since they prefer moister, better wooded environments.

INTRODUCTION

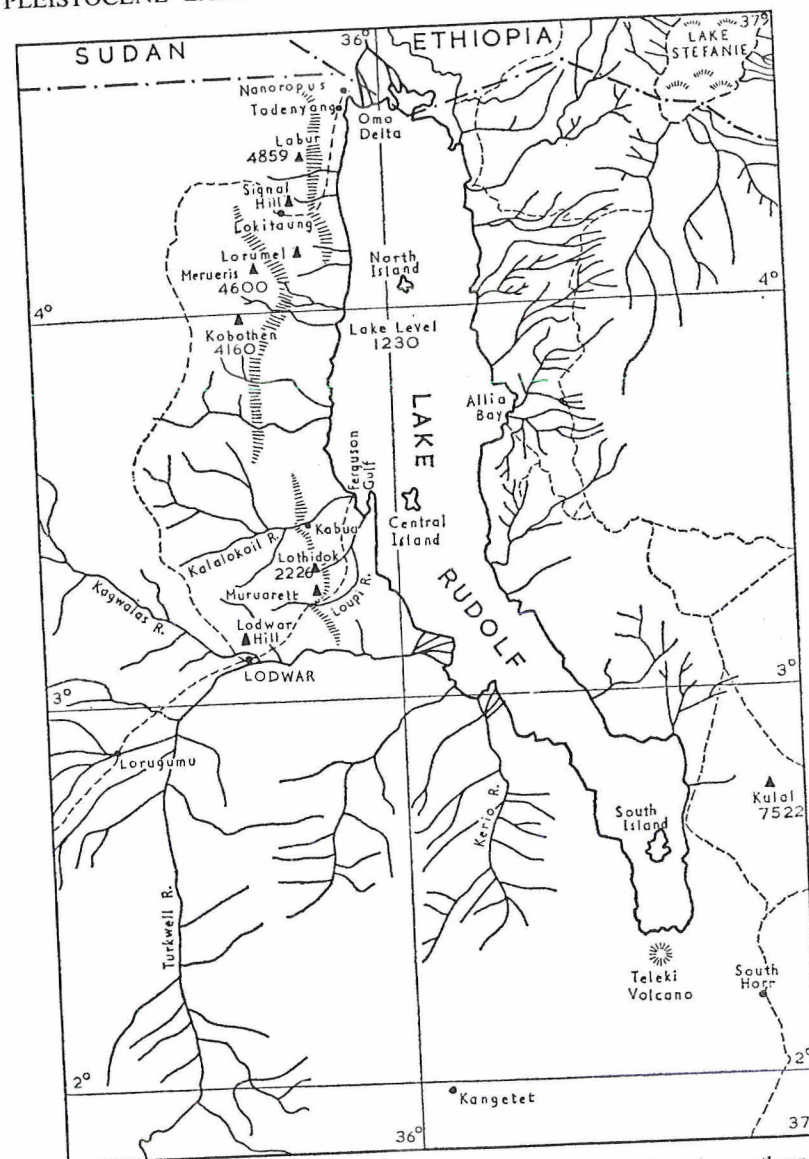
IN the summer of 1959, a party from the University of Durham visited the remote district of Turkana (Text—fig. 1) in northern Kenya, to study the geology of the region bordering the western shore of Lake Rudolf. First discovered in 1888 by the Austrian explorers Count Samuel Teleki and Rear-Admiral Ludwig von Höhnelt, Rudolf is the fourth largest permanent lake in Africa. It occupies a north-south trending fault graben, and lies at the centre of an internally drained basin of arid climate. Thus the waters of the lake are highly saline (a property immediately apparent from the abnormal buoyancy of the water and its soapy feel) and are subject to moderate and periodic fluctuations of level. The region about the lake has been volcanic since remote times; and, indeed, there is contemporary activity near the south end of the lake, where the shore is rocky and mountainous.

The country on the west side of the lake, traversed by the Durham expedition, is exceedingly inhospitable. In the south lies an extensive, gently undulating, sandy plain, with patches of rubble and sparse thorn trees of skeletal aspect, which is dotted with low hills or inselbergs of symmetrically conical profile (Plate 1, fig. 4). It is crossed by a few thin green ribbons of gallery forest (chiefly acacias and dom palms), arranged about the dry courses of the Kerio and Turkwell rivers which, with their tributaries, drain northwards off the frowning battlements of the 3,000 feet high Uganda escarpment into the southern half of Rudolf.

Beyond the Turkwell delta, this sandy plain is divided from the lake by a north-south range of low, rugged volcanic hills forming an east-facing escarpment and increasing gradually in height to the north to culminate in the impressive cliffs of Labur (4,859 feet). These hills are transected by numerous east-west drainage channels, some of which, as at Kabua and Lokitaung, travel on their way to the lake through deep gorges, floored with dark grey dust and shingle, derived from the black basaltic lavas. The western shoreline of the lake thereabouts possesses sandy beaches, often backed by high palm-clad dunes, which have in places been breached and thus converted into off-shore spits, enclosing saline lagoons. Despite the pronounced salinity of the lake, its waters teem with fish, notably Nile perch which may attain a weight of 200 lbs. This profusion of fish attracts and supports numerous colonies of birds, including pelicans, ibises and cranes. Between the shore and the hills lies a narrow, gently shelving strip of sandy plain about five or six miles across. Towards the northern end of the lake, the shore develops a closer covering of dry grass, and reeds appear, giving place eventually to quite thick bush and some swamp at the Omo delta which forms the northern limit of the lake.

North of the Turkwell, the Durham party encountered only one freshwater spring—that which feeds the important Kabua Water-hole. Elsewhere fresh water must be transported, or be obtained by digging to various depths in the beds of the dry river courses. Consequently the population of Turkana is extremely sparse, except at the administrative centres of Lodwar and Lokitaung, and consists of small, nomadic family

THE PLEISTOCENE LAKE BEDS OF KABUA, NORTHERN KENYA



TEXT—FIG. 1. Sketch map of Turkana and adjacent regions in northern Kenya, showing the disposition of lakes and river courses, principal roads (broken lines), settlements (black circles), and topographical summits (black triangles). The hachuring at the west side of Lake Rudolf indicates an eastward-facing escarpment.

groups, which subsist by herding camels, asses, goats and sheep. The tending of these animals is an arduous task, since their water must not only be reached by deep digging with primitive tools, but must then be passed up to the surface by a human, usually feminine, chain; and a single family group may possess many hundreds of beasts.

To the aridity of climate can be added the further discomfort of diurnal temperatures rising regularly to 120°F in the shade. Even wild game is scarce, except in the gallery forest along the river courses, which harbours some small antelopes, baboons and occasional leopards. Only a few gazelles and topi (the so-called bastard hartebeest), jackals and the striped hyaena inhabit the open plains of Turkana, together with hordes of small, nocturnal rodents. Our most lasting impressions of this empty, desolate land were the endless attentions of the flies, the dust, and the ceaseless flapping of the tarpaulins and tentage in the interminable wind blowing off the lake.

The Durham party was in Turkana from July to September, 1959. Near Kabua (Text—fig. 1), where the usually dry course of the Kalalokoil River emerges from the Lothidok hills on its way to join the lake at Ferguson Gulf, excellent outcrops of ancient lake beds were discovered, with terraces, and associated benches (Plate 1, fig. 1) cut in Miocene volcanic rocks. These lacustrine beds are thought to be of late Pleistocene age, an opinion with which Fuchs (1934) and Arambourg *et al.* (1943) concur.

The lake beds contain profuse fossilized mollusca and have yielded less well preserved remains of fossil mammals. The remains of a fossilized human skull of distinctly acromegaloïd type were also recovered from the Pleistocene lake sediments (Whitworth, 1960), being *in situ* in the lower part of the littoral facies of those beds. In places numerous weathered-out artifacts litter the eroded surface of the lake deposits. The artifacts fall into five groups, including: Kenya Stillbay flake tools in chert; a micro-lithic Upper Kenya Capsian industry; crude Sangoan hand-axes fashioned in lava; pressure-flaked, double-ended laurel-leaf points, probably of evolved Lupembian type; and a suite of uniserially barbed bone and ivory harpoon heads, resembling those from Ishango near Lake Edward (de Heinzelin, 1957). The presumed ranges of these industries are indicated in Text—fig. 2. The first three groups are believed to have been derived

STRATIGRAPHICAL DIVISIONS	EAST AFRICAN STAGES	PRESUMED CLIMATIC PHASES	EAST AFRICAN LOCALITIES	EAST AFRICAN INDUSTRIES
NEOLITHIC	NAKURAN	Alternating wet and dry phases	Njoro River, Apis Rock, Hyrax Hill, Ishango, Gamble's Cave.	ELMENTEITAN
MESOLITHIC	MAKALIAN			WILTON
UPPER PLEISTOCENE	GAMBLIAN	1st post-pluvial dry phase	Magosi, Deighton's Cave, Olduvai bed 5	MAGOSIAN
		4th Pluvial	Kabua, Lake Eyasi, Enderit Drift, Malewa Gorge, Gamble's Cave, Little Gilgil River.	KENYA CAPSIAN
		3rd Interpluvial	Major unconformities	KENYA STILLBAY
MIDDLE PLEISTOCENE	KANJERAN (Upper Kamasian)	3rd Pluvial	Olduvai bed 4, Ologesailie, Kanjera	LEVALLOISOID
	KAMASIAN (Lower Kamasian)	2nd Interpluvial	Rawi, Olduvai bed 3	KENYA FAURESMTIH
		2nd Pluvial	Rawi, Olduvai beds 1-2, Laetoli	SANGOAN
LOWER PLEISTOCENE	KAGERAN	1st Interpluvial	Kaiso, Marsabit, Omo.	ACHEULEAN
		1st Pluvial	Kanam, Omo, Kagera River.	CHELLEAN
				OLDOWAN
				KAFUAN

TEXT—FIG. 2. Sequence of stratigraphical stages of the East African Quaternary, with presumed climatic phases and corresponding industries.

from the lower half of the Kabua lake bed succession, and the Kenya Stillbay tools were nearly all discovered very close to the human skull of acromegaloïd type mentioned above. The Lupembian points came from the top of the Kabua lake bed sequence. The harpoon heads are believed to be Mesolithic, or even partly Neolithic, since a fragment of a similar bone harpoon was recovered from a much lower beach, which probably represents a very late stage in the recession of Lake Rudolf.

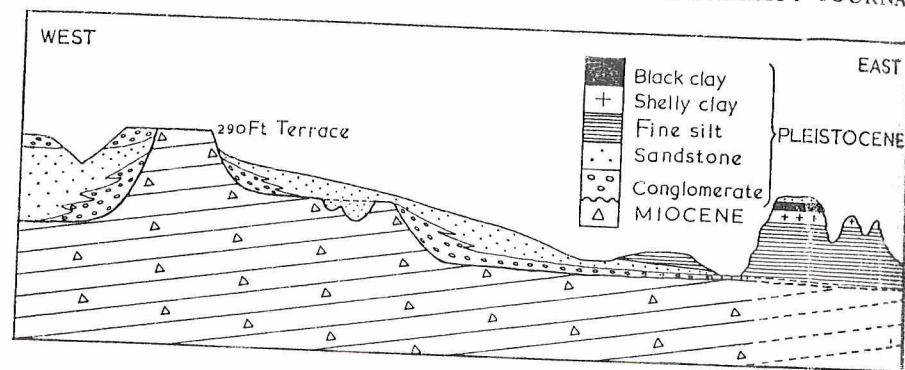
Acknowledgments are due to the Council of the Royal Society, the Trustees of the Boise Fund, the Government of Kenya, Brigadier P. W. P. Green, D.S.O. of East Africa Command, Dr. L. S. B. Leakey, Lieutenant-Colonel Hill, then District Commissioner of Turkana, and to Superintendent Ellis of Lokitaung, for the financial and other assistance which made the expedition to Turkana feasible.

THE LAKE BEDS

Fluctuations in the extent of the ancient Lake Rudolf during Pleistocene times have resulted in the occurrence of freshwater sediments far beyond the present confines of the lake. A striking example is provided by the presence of lacustrine Pleistocene beds on the eastern flank of Lodwar Hill, some twenty-five miles west of the present lake (Text—fig. 1). It has usually been presumed that the controlling Pleistocene influences were climatic and that there were pluvial episodes which could probably be equated with the similar wet periods elsewhere in East Africa. In fact, present knowledge of the Quaternary history of the Rudolf Basin is insufficiently precise to determine conclusively whether widely correlatable climatic changes or more local tectonic, erosional, and volcanic factors played the major role in the fluctuations of the lake; and the East African pluvial terms are used here mainly as convenient and rather loose stratigraphical stage names. There is, however, evidence that, at the maxima of the ancient Lake Rudolf, men and other mammals operated near its western margin in appreciable numbers, judging by the profusion and variety of artifacts and fossils at some localities.

Lake beds and benches representing these episodes of expansion and recession are well preserved at various places between the western margin of Lake Rudolf and the hills of the Labur and Lothidok ranges (Text—fig. 1). Often, the lacustrine deposits have been deeply dissected by recent erosion under semi-arid conditions. The Miocene lavas and agglomerates of the Lothidok range form a roughly north-south trending ridge with a maximum height of 1,000 feet above the lake (itself 1,230 feet above O.D.), and are frequently bounded in the east by normal faulting. During the Pleistocene fluctuations of the ancient lake, the Lothidok Hills and their northward extensions must have formed, for a time, a rocky western shoreline to the expanding lake. Consequently, thick prisms of lacustrine sediment were developed against the east flank of these hills, and at times of prolonged standstill benches backed by steep slopes or cliffs were carved in the bedrock. The Pleistocene lake beds were deposited adjacent to these benches, on them, and eventually, as lake level rose, were banked against the cliffs behind them.

According to Arambourg *et al.* (1935), lacustrine beds at the west side of Rudolf fall into two categories. The older series, which crops out near Todenyang in the extreme north of Turkana, he equates with the Omo Beds of southern Ethiopia and refers to Leakey's Kamasian stage of Central Kenya (presumably in the terminology of Leakey, 1931), although that stage is now commonly (but not universally) subdivided into Kanjeran, Kamasian *s.s.*, and Kageran stages (Text—fig. 2). The younger series, which Arambourg places in Leakey's Gamblian interlude (Text—fig. 2), is well developed along the eastern side of the Lothidok range, and it is with the excellent exposures of these beds in the area around Kabua Water-hole (approximately 35°47'E., 3°27'N.) that this account is primarily concerned.



TEXT—FIG. 3. Diagrammatic horizontal section through the Pleistocene lake beds and the underlying Miocene near Kabua Water-hole. (Vertical scale $\times 3$)

At that locality, the younger lake beds and associated benches are well exposed by deep gullying, which also reveals a strong, pre-lake bed topography, truncated by the lake margin bevels. In places, a buried landscape of old drainage channels, filled with Pleistocene sediments exhibiting a catenary dip relationship to the Miocene, is now being uncovered. Moreover, shelly Pleistocene lake deposits partly fill shallow valleys in the Miocene at the centre of the Lothidok range, showing that, at times, the residual hills must have formed a line of skerries in the ancient lake. At Kabua, there are remnants of three closely spaced benches cut in Miocene lavas and agglomerates (Plate 1, fig. 1) at heights approximately 200, 250 and 290 feet above present lake level. The relationships of the Miocene and Pleistocene are illustrated in Text—fig. 3. An occasional rock stack is also preserved; and off shore there are smooth, whale-backed reefs (in the sense of rock ridges at, or near, the lake surface) of Miocene lava, not unlike *roches moutonnées*. About $1\frac{1}{2}$ miles south of Kabua Water-hole, some of these reefs are now being divested of their covering of Pleistocene clays (Plate 1, fig. 3).

Immediately adjacent to the Miocene of the Lothidok range, a littoral facies of variable lake beds was developed, cross-bedded and conglomeratic, and cut by numerous minor, intraformational unconformities. The beds are banked steeply against the ancient cliffs with dips up to 45° . In one exceptional instance, occurring about $1\frac{1}{2}$ miles south of Kabua Water-hole, a dip of nearly 60° was recorded. These violent dips do not seem to be directly related to faulting. They are, no doubt, chiefly depositional, but are probably accentuated by a component due to compaction. Very quickly, within a few yards, the dips decrease to near horizontality, both outwards from the ancient cliffs, and upwards in the succession, while scree-like conglomerates give place to grits, sands and silts. There is no obvious evidence of slumping in the steeply inclined lake sediments.

Eastwards the entire Kabua sequence of lake beds changes rather rapidly into an off-shore facies in which silts and muds predominate, with only occasional sands and gravel horizons, although rare exposures of a lime-cemented basal conglomerate or grit occur. Near site KS.1A, $\frac{1}{4}$ mile south of Kabua Water-hole (Text—fig. 4), a representative succession of the inshore facies of the lake beds is exposed from the 200 feet bench in the Miocene upwards. About 300 yards to the north-east, a section of the finer grained off-shore deposits is exposed in the side of a large recent wadi. At these two localities, the successions are:

Inshore

40 feet clean white silty sands with occasional shells, and some gravelly or gritty horizons, gently dipping and uniformly bedded, or with some small-scale false-bedding. West towards the Miocene there is overlap and steepening dips.

Up to 25 feet pale brown sands with occasional horizons of orthoquartzitic grits, or chert and lava conglomerates. *The bulk of the mammalian remains are here.*

2 to 10 feet shelly littoral deposits with much local lateral variation and overlap. Range from sands and rare clay lenses, through sandy limestones and limestone 'breccia' to gravel and cobble grade conglomerates of well rounded lava blocks.

Off shore

Up to 4 feet clean white sand with sparse shells.

5 feet black to dark blue-brown mud with scattered shells.

10 feet very abundantly shelly fawn silts or sands, with occasional fish or crocodilian remains and flat calcareous concretions up to $1\frac{1}{4}$ feet across.

40 feet very fine pale buff to brown silts with subordinate sands, showing very regular and uniform horizontal bedding. Probably no shells *in situ*, or very rare.

2 feet lime-cemented, shelly conglomerates and/or coarse sands.

(base very rarely exposed)

Miocene lavas and agglomerates with occasional surface pockets of red lateritic bole.

Further north at Kabua Gorge the inshore facies is represented chiefly by sandstones. Although basal lava conglomerates are sometimes exposed, these are overlain by about 80 feet of very pale fawn sands, often of rather fine grade with lenses and bands of grit, containing rather rare molluscan shells, fossilized fish remains, and chelonian scutes. Usually the bedding is nearly horizontal, although there may be minor cross-bedding within individual units. Against the Miocene, however, the customary steepening of the dip occurs (Plate 1, fig. 2) and conglomeratic beds and heavy mineral streaks (olivine and pyroxene) predominate. About ten to fifteen feet of pebbly, lime-cemented grits, with well rounded lava and chert inclusions and rather plentiful bones and shells, cap the sands, from which they seem to be separated in some exposures by a disconformity. These rudaceous beds too are steeply banked against the Miocene rocks, and may show cross-bedding. Thus there is preserved at Kabua a clear stratigraphical record of the limited and slow advance of the lake, followed in due course by its intermittent retreat.

Northward from the tabulated section, the off-shore facies of the lake beds remains fairly constant, although the black mud band (which constitutes a well defined marker horizon) is overlain in the immediate vicinity of the Kalalokoil River by up to ten feet of grits and fine lava conglomerates, with some prominent shelly beds each about one foot thick. In addition, north of the Kalalokoil, the fine, fawn-coloured silts, which make up the lower part of the off-shore succession, contain scattered molluscan shells, undoubtedly *in situ*. Further east, however, the black mud thins and is overlain by up to 30 feet of richly shelly sands. To the south of the tabulated section, blue-grey clays, cream-coloured diatomite bands, and fawn or grey-green sandstones (with occasional, well rounded pebbly grits in the neighbourhood of the off-shore reefs mentioned above) are included in the off-shore succession of lake beds. In a dry river course about $1\frac{1}{2}$ miles south of Kabua Water-hole, small thrusts or slides are exposed, which cut, with a shallow westward dip, through these gently inclined off-shore clays and diatomites.

Molluscan shells were collected from the surface of the inshore beds at site KS.1 (Text—fig. 4) and, as was evident from the nature of the adhering matrix and the absence of rolling, had clearly been derived from beds similar to those underlying them and had travelled an insignificant distance from their stratal source. The richly shelly bed in the upper part of the neighbouring off-shore section outlined above yielded a

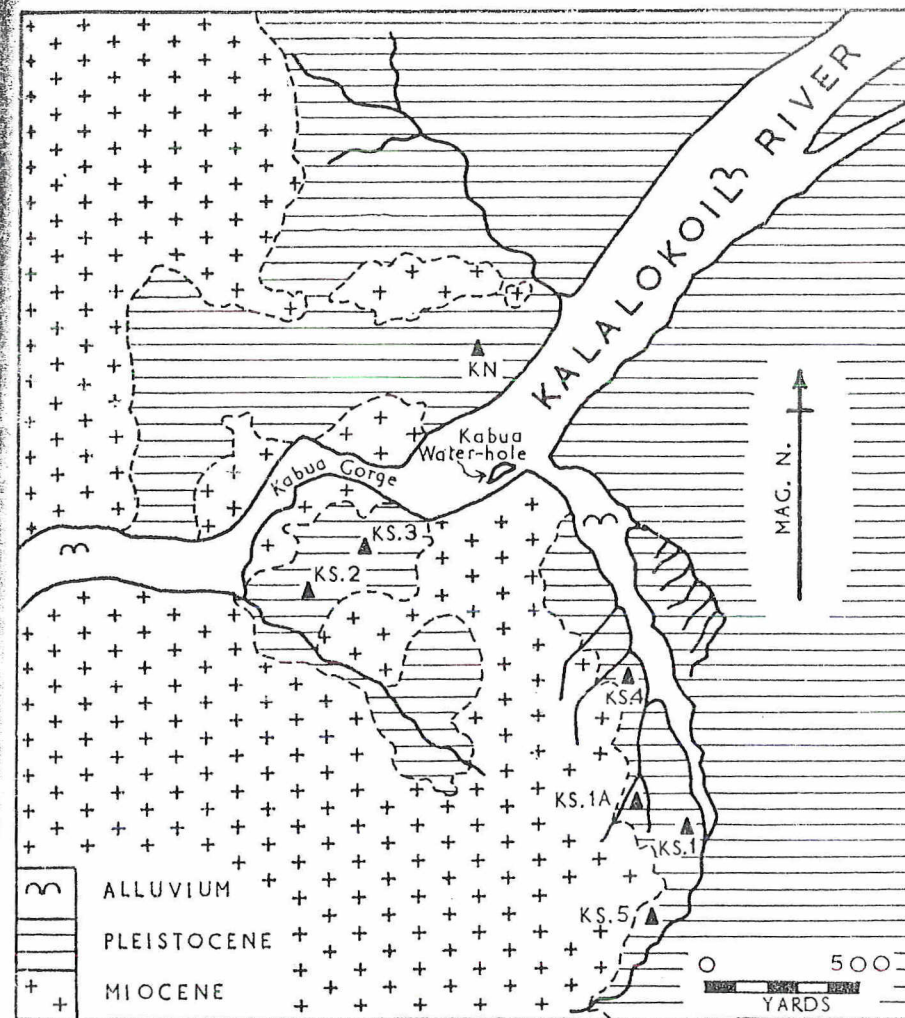
large number of excellently preserved fossilized mollusca which were *in situ*. The distributions and relative abundances of the molluscan species collected from the lake beds are as follows:

	Inshore	Off shore
<i>Viviparus unicolor</i> (Olivier), 1804	C	A
<i>Melania tuberculata</i> (Müller), 1774	C	VA
<i>Cleopatra pirothi</i> Jickeli, 1884 (3 to 9 carinae)	R	C
<i>Isidora</i> cf. <i>tchadiensis</i> Germain, 1905		R
<i>Planorbis</i> sp.		R
<i>Corbicula fluminalis</i> (Müller), 1774		C
<i>C. radiata</i> Parreyss, 1916		U
<i>Parreysia acuminata</i> (Adams), 1866		C
<i>P. bakeri</i> (Adams), 1866		U
<i>P. stuhlmanni</i> (Martens), 1897		R
<i>P. chefneuxi</i> (Neuville and Anthony), 1906	R	C
<i>P. rothschildi</i> (Neuville and Anthony), 1906		R
<i>Mutela truncata</i> Martens, 1914	R	U
<i>Aetheria</i> sp. (valves up to 200 mm. long)		C

VA=very abundant; A=abundant; C=common; U=uncommon;
R=rare.

All these forms, except *Parreysia stuhlmanni*, were reported by Roger (in Arambourg *et al.*, 1943) from terraces standing 50 metres above the present level of Lake Rudolf and situated near the north end of the lake. *P. stuhlmanni* does appear in Arambourg's faunal list for the Holocene lake deposits of Sanderson Gulf near Todenyang (Text—fig. 1), and is included more tentatively in his list for the older lake beds of Rudolf, which he classed as Kamasian. In addition, Fuchs (1934) referred briefly to the occurrence of oysters in lake beds a few miles from Kabua, and assigned them to the species *Aetheria elliptica* (Lamarck), 1807. On the basis of the molluscan fauna, both these authors concluded that the lake deposits occurring in the area between the Lothidok Hills and the western margin of Lake Rudolf were Gamblian, perhaps partly post-Gamblian. In so far as freshwater shells are reliable stratigraphical indices, the present assemblage from Kabua seems to confirm a rather late Pleistocene age for the source beds.

Other ancient beaches, representing temporary halts in the development of Lake Rudolf, are found in many places along the west side of the lake, between the present shore and the Lothidok Hills (see also Fuchs, 1934, p. 107), and are clearly defined in aerial photographs of the region. They are formed in fossiliferous, pebbly, brown sandstones and the surface mantle of derived gravel has yielded mammalian fossils, quantities of fish remains, principally vertebrae, spines and plates of catfish, together with some fossilized fruits, as yet unidentified, and rare implements. They are presumed to represent stadia in the retreat of the post-Pleistocene lake, subsequent to the formation of the topographically higher beds at Kabua. One of these ancient shorelines is preserved about four miles south-east of Kabua Water-hole, approximately 140 feet above present lake level, and has yielded a fragment of a bone harpoon head. Other ancient strandlines further south are situated four or five miles due east of the Lothidok range.



TEXT—FIG. 4. Simplified sketch map of Pleistocene and Miocene outcrops near Kabua. Principal fossiliferous sites marked by black triangles.

THE MAMMALIAN FOSSILS

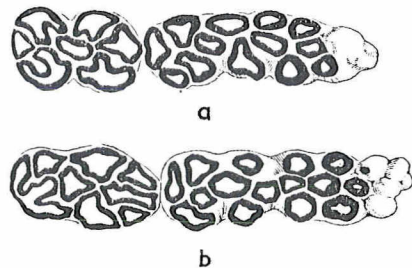
Numerous fragments of fossilized mammals were found in the vicinity of Kabua Water-hole, the precise location of the various fossiliferous sites being indicated in Text—fig. 4. A few fossils were *in situ*: the majority were surface finds, but unrolled and lacking sand-blast effects. The following groups were represented:

Rodentia. There are a few bone fragments and a pair of incisor teeth (British Museum of Natural History Registration Number M.20630) from site KS.1, which can probably be referred to the hystricomorph group, and represent a creature about the size of a cane rat.

Carnivora. A left mandibular fragment (M.20631) with second to fourth premolar and a right mandibular fragment (M.20632) with first molar, both from site KS.1A and probably referable to a single individual, are indistinguishable from the recent spotted hyaena, *Crocuta crocuta*. Today, only the striped hyaena seems to be present along the west side of Lake Rudolf.

Perissodactyla. A single damaged upper molar of the left side from KS.1 (M.20633) represents the family Equidae. It is, however, quite distinct from the corresponding teeth of recent African equines, such as zebra, bontequagga, quagga and ass, although it shows some similarities to *Equus burchelli* (see Cooke, 1950). The strongest resemblances to the Kabua tooth are found in the British Museum (N.H.) collection of the molar teeth of *E. oldowayensis* from Olduvai Gorge, Tanganyika, which only differ in their very slightly larger size.

Artiodactyla. Two, perhaps three, different pigs are represented in the fossilized remains recovered from the Kabua lake beds. A considerable quantity of material from site KS.1 (M.20634-20652) has been referred to *Potamochoerus koiropotamus*, since it is indistinguishable from the recent bush-pig. The collection includes mandibular and maxillary fragments, and there are isolated upper and lower tusks. There is also a phacochere, represented by isolated molar teeth and tusks from site KS.1 (M.20653-20661), which cannot be separated from *Phacochoerus aethiopicus*, the recent warthog.



TEXT—FIG. 5. Occlusal view of molar teeth of *Phacochoerus kabuae*. (a) left M_{2-3} ; (b) right M_{2-3} . Both natural size.

Finally, there are two fragments from KS.1, which may represent a second type of phacochere. One fragment (M.20662) is part of a left maxilla with second and third molars, the other (M.20663) is part of a right mandibular fragment, also with second and third molars. The material represents an adult individual (or individuals) with the third molar in each case in full wear; and the dimensions of the teeth are about two-thirds of those encountered in rather small individuals of *Phacochoerus aethiopicus*. In addition, the pillars of the third molars, although arranged in three longitudinal rows, do not seem to be quite as closely packed as in the corresponding teeth of *P. aethiopicus*. This small phacochere cannot be matched exactly in any fossil or modern pig material available to me, and I prefer to regard it as a distinct species which is here named *Phacochoerus kabuae* sp. nov. The dimensions of the teeth are given in Table 1, and the co-type specimens (M.20662-3) are illustrated in Text—fig. 5.

TABLE 1 DIMENSIONS OF MOLAR TEETH OF *Phacochoerus kabuae*

	Upper (M.20662)		Lower (M.20663)	
	a.p.	tr.	a.p.	tr.
M2 (mm.)	19.0	13.5	22.0	12.0
M3 (mm.)	33.5	12.5	34.0	11.5

Various fragments of indeterminate suilline remains were also recovered at KS.1 in close association with *P. kabuae*. They represent rather diminutive pigs, roughly equivalent in size to a small domesticated pig; and included are parts of three pelvic girdles, a scapula, two astragali and part of a tibia (M.20666-20673). Part of a mandible with the socket for a right lower tusk (M.20664) and another mandibular fragment with badly damaged third molar (M.20665) are both of phacochere origins, and may perhaps refer to *P. kabuae*.

A considerable part of a fossilized hippopotamus skeleton (M.20674), its bones encrusted with lake shells similar to those stratified in the Kabua lake bed succession, was found *in situ* at KS.1A, in the lower part of the pale brown sands division of the inshore succession (see p. 93). The remains were situated about twenty feet away from the acromegaloid human skull, mentioned previously, and at the same stratigraphical horizon. The bones were badly preserved, but parts of the maxillae and mandible were recovered. The teeth seem to be a little larger than those which occur in the largest adult male skulls of *Hippopotamus amphibius* available at the British Museum of Natural History. Their crown pattern is, however, virtually indistinguishable, except that the largest recent hippos sometimes possess rather stronger and more extensive basal cingula, and show a tendency to develop prominent accessory tubercles in the median lateral valleys of the molar crowns, which are not present in M.20674. There are also tusks, metapodial bones and a calcaneum of the same individual, all of which confirm its very great size. A quantity of similar material was collected at site KS.1, including mandibular fragments, isolated molar teeth and tusks, parts of a humerus and femur, a right cuboid, a calcaneum, and isolated metapodials and phalanges (M.20675-20691). The individuals represented were of very large size.

A number of isolated ruminant teeth, fragments of two independent maxillae and two mandibles, various limb bones and some bovid horn cores have been recovered at site KS.1. Most of these specimens cannot be identified with precision, but a number of resemblances can be detected. For example, there is a solitary upper third molar (M.20692) which shows pronounced similarities to the corresponding tooth in the recent bushbuck, *Tragelaphus scriptus*, but is smaller; and there are two fragments of horn cores (M.20693-4), also from KS.1, which can undoubtedly be referred to *Tragelaphus* sp. Site KS.1 has, in addition, yielded a right mandibular fragment (M.20695) bearing a fourth premolar which is very similar to that found in recent species of *Kobus* (the water-buck); and the associated horn core (M.20696) is very like those of the smaller recent species of *Kobus*. Furthermore, two isolated upper molars from KS.1 (M.20697-8) show a strong resemblance to the equivalent teeth of *Hippotragus equinus*, the roan antelope. Finally, a small, but complete, horn core of conical shape attached to part of a left frontal bone (M.20699) was found at site KS.1A. There can be little doubt that it represents a species of duiker (*Sylvicapra*).

A number of isolated ruminant limb bones from KS.1 includes an astragalus (M.20700) of bovid pattern and similar in size to the corresponding bone in the recent water-bucks; and there is another astragalus (M.20701) of a size appropriate to a roan antelope. There is also a number of indeterminate bovid molar teeth (M.20702-20706) from KS.1, and two fragments of bovid jaws which cannot be identified. One of the latter (M.20707) is a left maxilla with the fourth milk molar and the rather strongly selenodont first to second molars in place, and represents an antelope, roughly similar in size to an impala. The permanent teeth resemble two upper molars from the Lower Pleistocene of Omo, figured by Arambourg (1947; pl. 24, fig. 2), which he attributed to *Tragelaphus nakuue*. The other fragment (M.20709) is part of a right mandibular body bearing the third and fourth premolars and the anterior half of the first molar. This latter specimen is similar in size to the corresponding parts of an adult domestic sheep, although the teeth are only moderately high crowned with well developed roots, and the premolars are longer and less reduced than those of recent caprines. On the other hand, the third premolar is shorter and less complex than that found in species of *Tragelaphus*. There is some resemblance to the crown pattern of their counterparts in

the Lower Pleistocene 'antelope', *Menelikia lyrocera* (Arambourg, 1947), but there the teeth are larger and broader than they are in M.20709. An isolated molar (M.20708), also from KS.1, is probably conspecific with M.20707, mentioned above. In addition, a few isolated bovid molar teeth were recovered at sites KS.3 and KN, but they are badly preserved and unidentifiable.

Thus, the list of fossil mammals collected from the Kabua lake beds can be summarized as follows:

?Hystricomorpha indet.

Crocota crocuta (Erxleben), 1777.

Hippotigris cf. *oldowayensis* (Hopwood), 1937.

Potamochoerus koiropotamus (Desmoulins), 1831.

Phacochoerus aethiopicus (Pallas), 1766.

P. kabuae sp. nov.

Hippopotamus cf. *amphibius* Linnaeus, 1758.

Tragelaphus sp.

Sylvicapra sp.

?*Kobus* sp.

?*Hippotragus equinus* (Desmarest), 1804.

Bovidae indet.

It is significant that hardly a single member of this list is represented today on the hot arid grasslands with sparse scattered scrub and the coastal sand-dunes which now fringe the western margin of the increasingly saline Lake Rudolf; and it does not seem likely that these absences can be explained solely in terms of selective preservation as fossils. The forms listed above (particularly the antelopes) nearly all now belong to habitats vastly different from the present conditions obtaining around Lake Rudolf. For example, the spotted hyaena, although it may occur on fairly open plains, usually seems to prefer country containing areas of rather thick bush, deep grass, or patches of reeds, normally not far removed from water. The bush-pig is today only really plentiful in well wooded and watered territory, or in areas of thick bush; and even the warthog prefers thorn thickets and the neighbourhood of permanent water, although it may be found further afield. The antelopes from Kabua invariably show resemblances to recent groups of antelopes in which water- and shade-loving habits are strongly defined. The recent harnessed bush-buck, *Tragelaphus scriptus*, for example, is a browsing form which usually inhabits thickly wooded country, or areas with strips of dense bush never far from water, or alternatively lake-side reed beds. Similarly, the water-bucks (*Kobus*) seldom stray far from water and, except at night, prefer reeds and papyrus beds, dense bush, or close thickets. The roan antelope, *Hippotragus equinus*, is also confined rather close to water by its drinking requirements and, although it may wander farther than the other water-loving antelopes, favours country with at least some bush or forest cover. The recent duikers too are uncommon near deserts, always preferring plentiful cover and permanent water, and in some species extending their range into fully forested areas. Even the hippopotamus is probably somewhat rare in the conditions which now exist along the western shore of Lake Rudolf. The lake is bounded there by rocky beaches, or sandy beaches, backed by sand-dunes usually with sparse grass or very scattered scrub, except in the extreme north near the Omo delta. It is evident that the assemblage of fossil mammals collected from the lacustrine sediments near Kabua Water-hole represents an extinct fauna (even though individual species may have ranges from Middle Pleistocene to recent times) and that at some times conditions at the margin of the end-Pleistocene lake differed materially from those existing there today. There is perhaps some confirmation of this last conclusion in the recovery of Sangoan artifacts from the Kabua lake beds, since Sangoan industries are usually considered to be characteristic of forested regions.

Fossilized mammalian remains were also collected from the old lake beach, situated four miles south-east of Kabua Water-hole and standing about 60 feet lower topographically than the base of the Kabua lake beds. Included are parts of two equine molar teeth (M.20710). One is indeterminate, the other, although fragmentary, is clearly very similar to that recovered at site KS.1 (M.20633) and referred to *Hippotigris* cf. *oldowayensis*. There is also a very large atlas vertebra of a hippopotamus (M.20711). This bone confirms the immense size achieved by the race of hippos which formerly inhabited the Rudolf Basin, since it is slightly larger than the corresponding

bone in the specimen of *H. gorgops* from Kuguta, housed in the British Museum of Natural History (M.18504), and is about 30 per cent larger in its linear dimensions than the atlas vertebrae of recent adult skeletons of *H. amphibius* in the same museum. Two fragments of horn cores (M.20712-3) resemble those of the recent roan antelope, but are slightly smaller; and another horn core fragment (M.20714) might represent a large gazelle. This last shows some similarity to a portion of a Lower Pleistocene horn core from Omo, which Arambourg (1947; pl. 32, fig. 4) termed *Gazella praethomsoni*. There is, in addition, a quantity of indeterminate bovid remains, including two calcanea, one (M.20715) roughly equivalent in size to that of a small water-buck, the other (M.20716) belonging to a much larger antelope. There is also an isolated left central incisor (M.20717) and the proximal extremity of a right radius (M.20718) both derived from large antelopes of dimensions roughly similar to the modern roan.

THE AGE OF THE KABUA LAKE BEDS

A broad indication of the age of the lake bed succession cropping out near Kabua Water-hole is provided by an abundant fossil fauna of freshwater molluscs which are excellently exposed *in situ* in the silts of the off-shore facies. The shells are well preserved and undamaged, and are believed to indicate, in general terms, an Upper Pleistocene age (see pp. 93-4).

At present, the dominant process affecting the lake beds is erosion which has deeply dissected the deposits and left most exposures of the inshore facies mantled by a thin covering of gravel, with here and there an occasional pocket of finer hillwash. The gravel is a residual deposit of heavier and coarser materials from the lake beds, with pebbles and cobbles of Miocene lavas, reinforced by mammalian bones and teeth, and various artifacts. Nevertheless, remarkably few of the organic derivatives show even the slightest signs of rounding, and the great majority can only have travelled a very short distance from their source. Some mammalian fossils, as for example a group of hippo remains (M.20674), found at KS.1A about 20 feet above the base of the lake bed sequence, were definitely undisturbed; and it was evident by their occurrence that the bulk of the mammalian fossils belonged to the lowest third of the lacustrine succession. Unfortunately, the stratigraphical implications of these fossils are not very clear cut. It can only be said with certainty that the mammal assemblage from the Kabua lake beds is significantly different from the modern mammalian fauna of north-east Turkana. It is worth noting that, as far as it goes, this faunal assemblage shows some broad similarities to the fossil mammalian faunas collected at various other Pleistocene localities in East Africa, notably those from the Middle to Upper Pleistocene sediments of Olduvai Gorge in Tanganyika, and from similarly dated beds at Kanam and Kanjera in western Kenya; but, in particular, it resembles the fauna from the ?Upper Pleistocene *Africanthropus* deposits near Lake Eyasi in Tanganyika (see Dietrich, 1939). The presence of certain species, such as *Potamochoerus koiropotamus*, suggests that the source deposits of the Kabua fauna are probably younger than Middle Pleistocene.

It is, however, difficult to determine with any degree of certainty the provenance of other objects derived from the lake beds. Lupemban tools were found solely on the top surface of the lacustrine succession (that is nearly 300 feet above present lake level), and it was concluded that the Sangoan hand-axes might have been derived from a conglomeratic level, stratigraphically about 60 feet below the level at which the Lupemban tools were preserved; but the other tools found littering the eroded surface of the lake beds can only be separated typologically. Furthermore, the implements found near Kabua belong to a number of contrasting cultures, believed to be derived usually from distinct techniques, and sometimes to typify different climatic environments. Since they are part of a residual deposit, they may represent in condensed form a lengthy sequence of successive cultures. Alternatively, some at least of the various industries may have overlapped almost completely in the Rudolf Basin. For example, the Sangoan and Kenya Stillbay cultures are commonly regarded as substantially contemporaneous in Africa, the one characterizing the high rainfall forest region of Central and Western

Africa, while the other occurred simultaneously over the eastern part of the continent. Both Sangoan and Kenya Stillbay industries seem to have had a late Kanjeran to Gamblian distribution, being typically Upper Pleistocene. On the other hand, the two slender, bifaced stone points from the top surface of the lake beds at Kabua are probably Mesolithic; while the bone and ivory harpoon heads also collected near Kabua Water-hole show some resemblances to Mesolithic bone points from Ishango, to another bone point from the upper horizons of Gamble's Cave 2 in Central Kenya, and to a single ?Neolithic specimen from Nanoropus at the north end of Lake Rudolf.

There is, indeed, an embarrassing abundance of not easily reconcilable and rather imprecise information available within, and upon the surface of, the Kabua lake beds. The artifacts seem to indicate stratigraphical possibilities ranging from latest Kanjeran to Mesolithic, but with a bias perhaps towards a Gamblian dating (in the terminology applicable to Central Kenya). The fossilized mammals from the lake beds present an equally indeterminate picture. With few exceptions, the species represented in the assemblage collected in 1959 seem to be identical with, or closely similar to, modern species; but nearly all have ranges which are known to extend back into Middle Pleistocene times, and most of them are now excluded from north-eastern Turkana by ecological factors. Perhaps the most conservative assessment of all this evidence would be to place the bulk of the Kabua lake beds in the concluding stage of the Pleistocene, whilst recognizing that the uppermost horizons might be epi-Pleistocene.

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EXPLANATION OF PLATE 1

- FIG. 1. Looking west into the entrance of Kabau Gorge. The 250 and 290 feet benches, cut there in Miocene volcanic rocks, are clearly defined, the lower bench being in places overlain by, and enveloped in, lacustrine sands of late Quaternary age.
- FIG. 2. Looking north-east from the 290 feet bench down the dry bed of the Kalalokoil River towards Lake Rudolf at Ferguson Gulf. Lacustrine sands and conglomerates are banked steeply against dark coloured Miocene agglomerate, and show some cross-bedding.
- FIG. 3. An ancient, wave-rounded, off-shore 'reef' of Miocene lava, situated about $1\frac{1}{2}$ miles south of Kabua Water-hole, now being stripped of its Pleistocene cover of lacustrine sediments by recent erosion.
- FIG. 4. View of the Turkana plain near Lorugumu, looking south-east.



FIG. 2

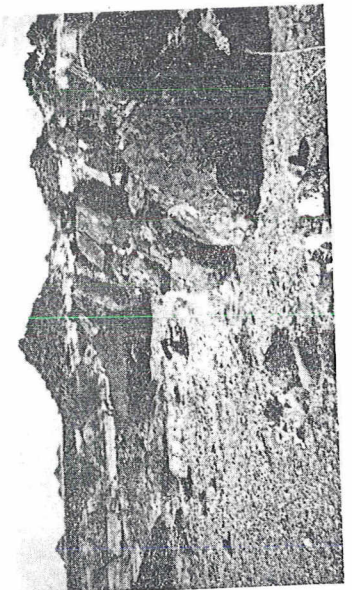


FIG. 4

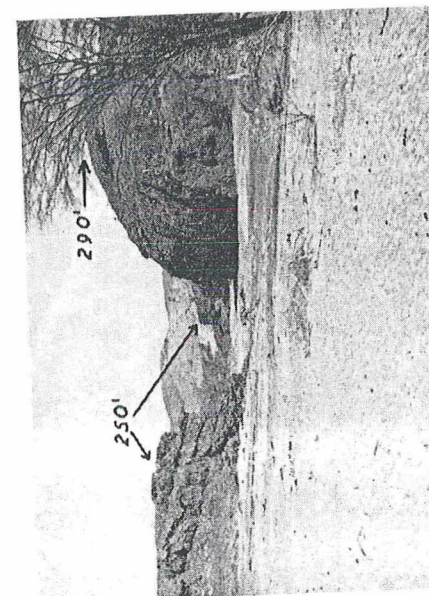


FIG. 1



FIG. 3