MIOCENE BEDS OF THE VICTORIA NYANZA.

By Felix Oswald, D.Sc.

In 1909 Mr. G. R. Chesnaye, at the close of a prospecting expedition down the Kuja valley, came across some bones of fossil turtles and crocodiles in the low cliffs of Karungu Bay below Nira Hill. On his return to Nairobi he showed the fossils to Mr. C. W. Hobley, who induced the late Mr. D. B. Pigott to undertake a search for further specimens. His interesting discovery of part of the lower jaw of a *Dinotherium* in these beds near Karungu has already been referred to in this Journal (Vol. II, No. 4, July 1912, p. 109 and text-figure) by Dr. C. W. Andrews, F.R.S., who appropriately named the specimen *Dinotherium Hobleyi*, and ascribed a Lower Miocene (Burdigalian) age to the strata. Owing to the unfortunate demise of Mr. Pigott little or nothing was known of the circumstances of his discovery; accordingly I offered to utilise my leave in making a geological investigation of the locality and in collecting fossils for the British Museum, and I arrived at Karungu at the end of November 1911. In the meantime Dr. A. D. Milne had visited Nira Hill, and just before my arrival Mr. R. J. Cuninghame, in conjunction with Mr. G. R. Chesnaye, had procured several specimens of chelonian and crocodilian remains.

To some extent a disappointment awaited me, for, contrary to my over-sanguine expectations, there was no bone-bed, nor was there any chance of obtaining complete skeletons, for the bones only occurred isolated at wide and uncertain intervals and usually in a shattered condition. Moreover, the outcrop of the Miocene beds is unfortunately extremely restricted, for they appear to view only in a few places along the southern margin of a large volcanic plateau, of which Gwasi is the central point, rising nearly 3,000 feet above the Nyanza. Their outcrop is still further diminished by a thick mantle of black 'cotton-soil' or *regur*, derived from the decomposition of the nepheline-basalt. They are exposed to view at the base of Nira Hill and to the eastward in the gullies of

Kachuku and at the base of the basalt cliffs of East Kachuku and Kikongo.

Broadly speaking, these Miocene sediments, brought down by a large river and deposited in the lake, may be classified into three groups, which I divided into 37 beds :—

1. An *Upper Series* (Beds 1–12), about 70 feet thick, of grey and brown clays and shales, with occasional beds of grey sandstone and thin seams of travertine.

2. A *Middle Series* (Beds 13–25), about 30 feet thick, of variable red and grey clays with white sandstones in the lower half.

3. A *Lower Series* (Beds 26–37), about 35 feet thick, of buff sandstones, calcareous conglomerates, and torrential gravels (containing the *Dinotherium* zone), passing down into clays and marlstones.

Travertinous beds occur at frequent intervals throughout the whole succession of strata, which do not exhibit any unconformity.

At Nira the Miocene beds rest on an uneven floor of a fine-grained amphibolite (hornblende-rock) belonging to the ancient gneisses and schists which are so widely distributed on the eastern and southern coasts of the Victoria Nyanza. At Kachuku, however, the lowest beds lie on a quartz-ironstone breccia which faces the Kuja plain in a low cliff. Probably this breccia of angular fragments of quartz embedded in limonite represents the weathered detritus of old amphibolites or hornblende-schists composing the original land-surface which was invaded by the advancing waters of the lake in Lower Miocene times.

The initial depression of the land must have taken place with relative rapidity, for the lowest bed (No. 37) is not a gravel or a sandstone but a fine clay, indicating that it was deposited in fairly deep water at a considerable distance from land. This mottled crimson and yellow clay becomes wholly red in colour in the proximity of a quartz-vein, which has not only traversed the underlying platform of hornblende-rock, but has even forced its way into this red clay ; and the red colour, penetrating every crack and joint of the clay, is probably

due to hot ferruginous water connected with the injection of the quartz-veins.

The earth movements which gave rise to the deepening of the lake were doubtless responsible for the great activity of calcareous springs depositing frequent beds of travertine above the red clay (e.g. at Kachuku). Whenever the travertine became mingled with clay deposited at the same time, bands of hard, brown marlstone (Nos. 32 and 34) were the result, alternating with brown clay and enclosing shells of *Ampullaria ovata, Lanistes carinatus* and *Cleopatra bulimoides.*[1] Whilst these beds are very clayey at Nira they are represented at Kachuku by pebbly sandstones, showing that the river which brought down the sediments must have flowed from east to west, and in all probability it followed a very similar course to the present Kuja River.

The most important beds of the whole series are the torrential and current-bedded sandstones and gravels of No. 31, which are particularly well displayed in the gullies of Kachuku (Fig. 4), for they comprise the zone in which I found bones of *Dinotherium Hobleyi* (mandible, tusk, &c.), and of Anthracotheres of different sizes, some allied to *Hyopotamus* (humerus, tibia, rib, and tusk) and probably leading a very similar existence to the present hippopotamus, and a small mandible of a form similar to *Ancodus*, a tooth of the hornless rhinoceros (*Aceratherium*), the mandible of a small cat-like carnivore closely allied to *Pseudaelurus*, the astragalus of a Creodont, part of the carapace of a giant tortoise, scutes of *Trionyx*, teeth of crocodile, &c., and a very few landshells (*Cerastus cf. Moellendorffi* and *Limicolaria*), as well as the lacustrine *Ampullaria ovata* and *Cleopatra bulimoides.*

The upper limit of these bone-bearing beds is readily recognisable, for it is formed by a thick conglomerate (No. 30) of white calcareous nodules (with concentric coats) from an inch or two up to 2 feet in diameter.

The currents must have been particularly strong at this time to keep such large nodules in active motion, so as to permit the formation of this exceptionally coarse oolite in

[1] The vertebrate remains which I collected have been named by Dr. C. W. Andrews, and the mollusca by Mr. R. Bullen Newton.

Fig. 1. HEAD OF GULLY AT NIRA, LOOKING N.E. BY E.
B, basalt of Nira Hill.

Fig. 2. HEAD OF GULLY AT KACHUKU, LOOKING N.E.
The basalt peak of Nundowat in the distance.
b, black earth.

the lime-laden waters of the lagoon or shallow gulf of the Victoria Nyanza. It was succeeded by another well-marked torrential period, during which the river deposited coarse gravels (Nos. 26–29), with a calcareous cement, deriving their constituents from gneiss, andesite, jasper, and quartz, occurring *in situ* in the country 20 to 30 miles to the eastward, and especially derived from the volcanic agglomerate of Metamala.

During the period represented by the Middle Series (Beds 13–25) the river-system was becoming mature, so that torrential beds were exceptional and temporary, and are confined to the lower half, whilst in the upper half red clays predominate, interrupted by occasional seams of travertine, often mixed with clay. A thin, orange gravel (No. 24) near the base of the series (Fig. 2) is of special importance on account of the number of teeth it contains, comprising those of *Dinotherium*, rodents (probably ancestral to the cane-rats), crocodiles, and of the lungfish *Protopterus* (hitherto unknown in a fossil condition). One of the white sandstones (No. 22) is so hard that the fossils it contains are exceptionally well preserved, in particular a Proboscidean tibia, perhaps of *Dinotherium* or *Tetrabelodon*, and a complete carapace of *Trionyx*.

Intercalated among the upper red clays (Fig. 3) is a thin grey sandstone (No. 16), containing a few small jawbones which Dr. C. W. Andrews has determined to belong to a remarkable form, related to *Hyrax*, with some rat-like characteristics doubtless due to convergence. Still higher in the series a hard red marlstone (No. 14), often travertinous, contains abundant casts of the shells of *Ampullaria ovata* (with opercula) and *Lanistes carinatus* with fragmentary crocodilian and chelonian remains. This bed forms a remarkably persistent horizon and is readily recognisable from its tendency to form a wide terrace (as at Nira) and the edge of a cliff (Fig. 2). The red colour of this marlstone and of its associated clays (Nos. 13 and 15) diminishes towards the east and has become greenish-grey at Kikongo, five miles east of Nira. Their redness may perhaps indicate the activity of ferruginous springs at the time of deposition. Discontinuous layers of calcareous concretions occur in the clays and probably owe their irregular

and sometimes fantastic shapes to the action of gentle currents disturbing the uniform deposition of the travertine.

Finally the Upper Series (Nos. 1–12), although equal to the combined thickness of the Middle and Lower Series, consists mainly of grey and brown clays and shales with scarcely a trace of fossils. It is only in the lowest bed (No. 12) that fossils are still present to any extent, e.g. a river-crab (*Thelphusa*), bones and scutes of crocodile, &c. At Kachuku I found crocodiles' teeth with *Ampullaria ovata* in the grey clay of No. 5, but this was the highest level at which vertebrate remains occurred.

These clays were evidently deposited at a time when the rivers had nearly reached their base-level, and were normally only able to deposit fine mud which was probably derived mainly from the much-weathered and decomposed gneiss of the Kamagambo peneplain. Thin seams of travertine are frequently intercalated with the clays.

It needed some exceptionally wet season to bring down coarse sandy material in order to form the grey, current-bedded sandstones, which occur at rare intervals and often pass laterally into grey clay. The only one of these bands (No. 8) that persists throughout the area is about 6 feet thick; it forms a noticeable ledge in the upper part of the main gully at Nira (Fig. 1) and is composed of quartz-grains with plates of biotite and small crystals of augite. At Kikongo I found it to contain a few land-shells (*Tropidophora nyasana, Limicolaria,* and *Cerastus*).

In the topmost bed of grey clay (No. 1) the petrified stems of extinct species of trees occur, allied to *Bombax*, laurels, &c., and are particularly well preserved at Kikongo. They were the result of quite unusual circumstances by which water-logged trunks were calcified by the agency of calcareous springs, the wood being replaced by lime, particle by particle, so that when thin slices of the fossil stems are prepared and placed under the microscope the most delicate cell-structures are revealed as clearly as if the sections had been made from living plants.

It is somewhat surprising that the fossil shells consist entirely of gasteropods to the complete exclusion of bivalves. This would seem to indicate that the strata were laid down so

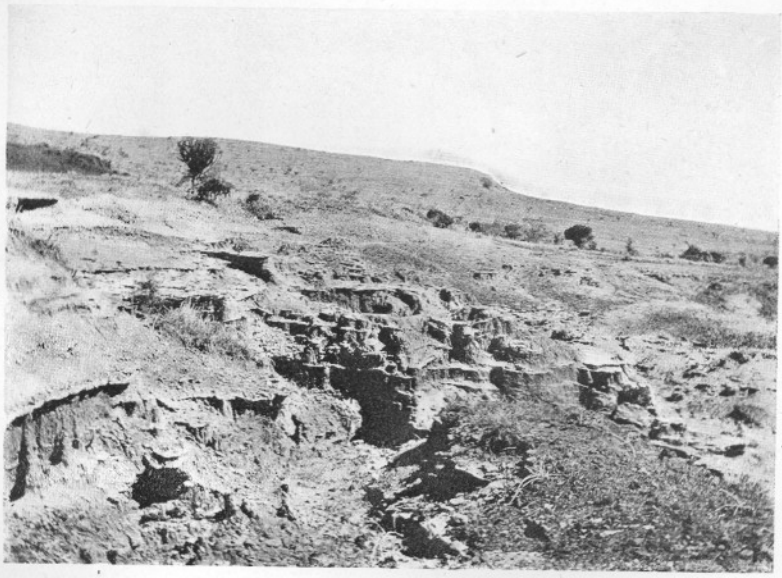

Fig. 3. EASTERN PART OF GULLY AT KACHUKU, LOOKING S.E.
The basalt cliff of East Kachuku in the distance.

Fig. 4. LOWER PART OF GULLY AT KACHUKU, LOOKING N.E.
The basalt peak of Nundowat in the distance.
D, *Dinotherium* zone.

far away from the land as only to permit of the inclusion of chambered shells capable of floating and drifting for a considerable distance before becoming waterlogged and sinking to the bottom. Whilst sailing on the Victoria Nyanza gasteropod shells may be frequently observed floating at a considerable distance from the land, and they may be driven by winds and currents for many miles before they finally sink.

As Dr. Andrews has pointed out, the vertebrate fauna of these Miocene beds is closely similar to that occurring at Mogara in the Libyan Desert and presents affinities to the fauna of beds of similar age in Beluchistan.

At all the outcrops, from Nira to Kikongo, the dip of the Miocene beds is constant, viz. 8° N. by W. This uptilting may be due to the sagging down of the earth's crust in this region by the enormous weight of the thousands of feet of lava which have been poured out and piled up by the volcanic vents of Gwasi. It is true that Captain H. G. Lyons has come to the conclusion that the northern coast of the Victoria Nyanza is gradually sinking—to the extent of 80 cm. in nine years at Entebbe—but this depression can hardly be connected with the uptilting of the Miocene beds near Karungu, or else we should expect to find the Kavirondo Gulf increasing in depth. It is, however, well known to be steadily becoming shallower.

Owing to this northerly dip the Miocene beds soon disappear completely beneath the basalt plateau of Gwasi. No trace of them was visible even in the deep and wide meridional valleys of Kitama and Kikongo, which must have been excavated in the soft deposits prior to the outflow of the nepheline-basalt.

To the south the uptilted beds are thinning out rapidly, and, moreover, in this direction they would naturally occur at a higher and higher level, but they have been completely denuded away when the lake stood higher than at present, and there was not the smallest trace of them in the hills of granitic gneiss to the south of the wide Kuja valley. The only chance of finding any further outcrops lay in my searching along their line of strike, viz. to E. by N., but to the east of Kikongo the basalt no longer rested on the Miocene deposits, but on an ancient augite-andesite, from which the Miocene strata had previously been denuded away excepting for a small

patch of the upper series on the left bank of the Kuja, near the Ogo ford, 15 miles inland from the lake. Here the grey shales and clays are identical in character with the typically unfossiliferous upper beds; they occur on the same line of strike as Kachuku and approximately at the same level and they exhibit the same dip, viz. 8° N. by W.

It is a remarkable instance of the persistence of freshwater forms that although the vertebrate remains clearly indicate the Lower Miocene age of these deposits the fossil shells without exception belong to species which are still living in Equatorial Africa. *Ampullaria ovata,* however, is the only one of these Miocene shells that occurs in the Victoria Nyanza at the present day. *Lanistes carinatus* is not found nearer than the Tana River, whilst the nearest recorded localities for *Cleopatra bulimoides* are at Mombasa and in the Lake Rudolf region.

Every year a greater area of the fossiliferous beds will be exposed, for the heavy rains not only wash away the soft black cotton-soil overlying the beds, but the gullies are temporarily filled with swollen torrents, which scour away the soft clays so as to undercut the sandstone ledges, which break away into slabs when unsupported. Thus fresh specimens of fossils will continually become exposed to view. Dr. Andrews has already indicated in his article in this Journal the importance of these isolated and scattered bones, and how they can throw light upon the early distribution of animals in Africa as well as upon the origin of the present fauna. Very valuable results may be attained if any visitor to Karungu will turn aside to inspect the gullies of Nira and Kachuku and to secure for the British Museum any fossil bones or teeth which he may discover, noting carefully and photographing the exact bed in which they occur.