WILLIAM NORTH RICE.

1845-1928.

WILLIAM NORTH RICE, teacher of geology for more than half a century, widely honored among scientists and loved by all who knew him intimately, died November 13, 1928, in his eighty-third year. His death occurred in Delaware, Ohio, at the home of his son; but the funeral services were held at Wesleyan University, Middletown, Connecticut, where he had spent the greater part of his long and useful life.

Professor Rice was the "Grand Old Man" of Wesleyan. He did his undergraduate work there during the Civil War, and later went to Yale where in 1867 he was awarded the first Ph.D. degree in Geology. After a year in Berlin he became a member of the faculty at Wesleyan, and his service there continued unbroken until his retirement in 1918. In addition to his teaching work he was active in administrative duties, and on two occasions he held the position of acting president. Wesleyan pays high tribute to his service in organizing the curriculum, as well as to his ability in teaching geology and natural history. From 1903 to 1916 he was superintendent of the Connecticut Geological and Natural History Survey. Some of his best known scientific writings deal with the geology of Connecticut.

Few men have been active scientists and ordained ministers at the same time. Professor Rice had this distinction. As he himself humorously expressed it, he was *amphibious* with respect to the elements science and religion. During the early part of his career the conflict between these elements was a serious matter. Evidently he faced the issues early, for the subject of his doctor's dissertation at Yale was "The Darwinian Theory of the Origin of Species." Inasmuch as the theory had been published only a few years before, it was still a new subject to many scientists as well as to laymen in America. Rice's views got him into trouble with his church more than once, but he weathered the storm. In the meantime he continued to preach the harmony of science and religion, and much of his writing as well as his teaching was aimed at ending the mistaken conflict. Evidently he accepted this attempt at mediation and interpretation as his principal mission in life. Titles of his books, such as "Christian Faith in an Age of Science," and "The Return of Faith," indicate their appeal to laymen of the Church.

William North Rice was unassuming and kindly, but a man of firm convictions. He was a wholesome influence on the campus, where even the students came to know him affectionately as "Billy." His passing will be mourned by large numbers of former students as well as by his associates in science.

CHESTER R. LONGWELL.

AMERICAN JOURNAL OF SCIENCE

FEBRUARY 1929

A REVIEW OF THE FOSSIL MAMMALS OF CENTRAL AFRICA.*

A. TINDELL HOPWOOD.

Some time ago my friend Dr. G. G. Simpson, of the American Museum of Natural History, asked me to write a short account of our knowledge of the fossil mammals of Central Africa. This is a subject in which I am especially interested, and I have derived both pleasure and profit from trying to comply with Dr. Simpson's wish. In the following pages I have attempted to do several things. First I have tried to show the general development of our knowledge of the fossil mammals of Africa up to 1911. After that date I have dealt only with the mammals of the special region selected for review, but mention is made of certain papers on the mammals of other parts of Africa when they seemed to have some bearing on the subject. Secondly, the faunas of Central Africa are analyzed, mention being made of points of interest in the different mammals. Then the age of the various deposits is dealt with, and reasons are given for a belief that they are younger than beds elsewhere which contain faunas of similar type. Lastly, attention is drawn to the fact that, so far as the evidence takes us, the major part of the African mammals are immigrants, and that autochthonous groups are few.

It is advisable to point out that, in using the term Central Africa I refer especially to those parts which are under British Control. These are Kenya Colony, Uganda, Tanganyika Territory, Nyasaland, and Northern Rhodesia. The western half of Central Africa, so far as I know, is quite unexplored palaeontologically, and no material has reached the British Museum.

SOURCES OF INFORMATION.

At the beginning of this century the fossil mammals of Africa were almost unknown. Pomel (1893-1898) had pub-

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lished a series of monographs dealing with the late Pliocene and Pleistocene faunas of Algeria. These revealed an assemblage essentially African in character which did not differ greatly from the modern fauna of North Africa. Apart from these monographs, and a few scattered papers, notably those by Owen (1875) and Dames (1894), there was nothing on which to base any opinion concerning problems of distribution and migration.

The next step was taken when the late Dr. C. W. Andrews described the vertebrates found in the Upper Eocene, and Lower Oligocene deposits of the Fayûm. After a number of preliminary papers (Andrews, 1899, 1901, 1902, 1903, 1904, 1905) he published (1906) "A Descriptive Catalogue of the Tertiary Vertebrates of the Fayûm, Egypt." Other papers by Andrews (1907, 1908), Osborn (1906, 1908, 1909, 1910), Schmidt (1913), Schlosser (1911), and Stromer (1906, 1911) followed. Those by Stromer are of especial interest since they compare the African faunas then known with those of Europe from the Eocene to the Pleistocene.

Up to this time nothing was known of the fossil mammals of Central Africa, and it is significant that no mention is made of the region in Osborn's "Age of Mammals" (1910). The next year, however, Haug (1911, p. 1727) gave a short account of mammalian remains from the region to the north of Lake Rudolph. The specimens were collected by de Bozas some eight or nine years before, and included *Hipparion, Rhinoceros, Hippopotamus, Phacochoerus, Buffelus, Camelopardalis, Deinotherium,* and *Elephas.*

The next collection comprised a series of remains from the neighborhood of Karungu, and from Homa Mountain, both on the east of Lake Victoria. The specimens from Karungu were described by Dr. Andrews (1911, 1914); they included *Deinotherium, Myohyrax, Merycops, Paraphiomys,* and *Pseudaelurus;* those from Homa Mountain were described in part by Dr. Andrews (1916), and in part by myself (1926a). The genera present were *Hippopotamus, Metridiochoerus, Phacochoerus, Bos, Elephas,* and *Simopithecus.*

At the time Dr. Felix Oswald was making the collections at Karungu and Homa, Prof. Hans Reck was leading a party of geologists in Tanganyika Territory, which was then in German hands. There, in the region known as the Serengeti Plains, and especially at Oldoway, they excavated a great quantity of bones which, even now, have been studied only in part.

Various papers by Branca (1914), Dietrich (1916, 1925, 1928), Reck (1914, 1926, 1928) and others, have established the type of fauna. It includes *Hipparion, Rhinoceros, Hippopotamus,* pigs, dogs, buffalo, numerous antelopes, a baboon, *Elephas,* and perhaps *Mastodon.* A human skeleton was found in the same beds. The record of *Helladotherium* is erroneous; it was based on a long bone of *Hippopotamus* (Dietrich, 1928, p. 36).

The Kaiso Bone-beds first attracted attention when Dr. Andrews (1923) announced the presence of a chalicothere among some bones sent home for identification. With the aid of a grant from the Percy Sladen Memorial Trust, Mr. E. J. Wayland, Director of the Geological Survey of Uganda, visited the district to make further collections. Although there were no more chalicothere remains the fossils were of great interest. They included *Rhinoceros, Hipparion, Equus, Sus, Hylochoerus, Hippopotamus,* numerous antelopes, and *Elephas* (Hopwood, 1926b).

Remains of *Hippopotamus* and of a bunolophodont mastodont have been reported from the Chiwondo beds of Uraha Hill, Lake Nyasa (Hopwood, 1927). They were collected by Dr. F. Dixey, Director of the Geological Survey of Nyasaland.

The only locality of note in Rhodesia is the Broken Hill mine. This was described by Chubb and Mennell (1907). I have examined a great quantity of bones from the same place; they are all referable to recent genera, and the only feature of any interest is the much-debated Rhodesian Skull.

The fossil mammals of South Africa are all of comparatively recent date. They have been described by various authors, (Beck, 1906; Broom, 1925; Fraas, 1907; Haughton, 1921; Scott, 1907), and the general assemblage differs from those of the same date in Central Africa only in matters of detail.

The most important paper of recent years is one by Stromer (1926) in which he dealt with a number of small mammals, mostly rodents, from South West Africa. Among the new genera are *Metapterodon, Austrolagomys, Pomonomys, Myohyrax, Diamantohyus,* and *Propalaeoryx.*

ANALYSIS OF THE FAUNAS.

The Younger Fauna.

If we now attempt to analyze the faunas listed above we find that there are several items of interest. The Lake

Rudolph fossils attract attention from the presence of *Deinotherium* and *Hipparion*. The former is also recorded from Karungu where it was found in beds referred to the Miocene. The latter is known from Oldoway and Kaiso. I am of the opinion that there are two faunas by Lake Rudolph, and that the *Deinotherium* is representative of the older, all the other genera belonging to the younger. If this hypothesis is accepted the younger fauna is found to agree with those from Homa, Kaiso, and Oldoway. It is only an enriched phase of that found in Africa today; how close to the modern fauna it is appears from the following paragraphs.

Hipparion and *Equus* are known from Lake Rudolph, Kaiso, and Oldoway. There are at least two species of *Hipparion* That from Lake Rudolph is said by Haug to resemble *H. libycum* Pomel. If this be correct then it is very different from *H. albertensis* Hopw. from Kaiso. The latter is distinguished by its very high molar crowns, and by the complicated folding of the enamel. In both of these details it differs from *H. libycum*. No description of the Oldoway species has yet been published. A single, well-worn tooth of zebra from Kaiso does not differ from the recent species *E. zebra* Linné.

There is not sufficient information to allow of any definite statement about the rhinoceroses. *R. scotti* Hopw. from Kaiso and *R. whitei* from Broken Hill are very close to the recent *R. simus*. The first species has been recorded, as *R. simplicidens* Scott *non* Koken, from the coast of Zululand. It was probably widely distributed. Hilzheimer (1925) identified as *Diceros simus* var. *germano-africanus* nov. the remains from Oldoway. Thus all the fossils known are typically African.

In dealing with the species of *Hippopotamus* one is handicapped, not only by the fragmentary material, but also by the apparently homogeneous nature of the genus, the species of which differ very little among themselves. The most satisfactory account is that by Dietrich (1928). He describes a skull and limb-bones as *H. gorgops* n. sp. This species differs from the recent *H. amphibius* in several respects, of which Dr. Dietrich selects the following as the most important: (1) the orbits are placed so high that their lower border is above the plane of the upper surface of the snout: (2) the orbits look much more directly forward; (3) a massive bony swelling on the antero-superior orbital margin; (4) a low, flat face; (5) the rectangular, almost square cross-section of the nasal passages behind the snout. All these features, together with others of less importance, indicate that *H. gorgops* was even more amphibious than the recent species.

From Kaiso there is known a pygmy species, *H. imaguncula*, which was not more than one metre high at the shoulder. It is intermediate between the very variable *H. madagascariensis* and *H. (Choeropsis) liberiensis*. The limb-bones, although distinctive, partake more of the characters of the latter, whereas the dentition has more in common with the former.

Hippopotamus amphibius was found at Homa, Kaiso, and Uraha, Nyasaland. The remains from the last mentioned locality are very fragmentary. Those from Homa belonged to an animal which agreed rather with those European forms often referred to *H. major*, than with the recent animals. At Kaiso was found *H. amphibius kaisensis* which differs from the norm in its stouter molars, and in the more simple articulatory facets of the limb-bones.

Pigs of one sort or another are a characteristic feature of the modern African fauna, which agrees in this respect with that of Pleistocene time, only that the latter was more varied. Wart Hogs, indistinguishable from the recent *Phacochoerus aethiopicus* L., were found at Homa, and the genus is also known from Oldoway. A giant species of *Hylochoerus* (*H. euilus* Hopw.) occurs at Kaiso, as well as a true *Sus* (*Sus limnetes* Hopw.). *Metridiochoerus*, which may be congeneric with *Notochoerus* Broom, was obtained from Homa Mountain and Oldoway. It is a very hypsodont form with rooted molars, and represents an evolutionary stage between *Hylochoerus* and *Phacochoerus*, although the three genera do not belong to the same lineage.

Sus limnetes is a large form in which the third lower molars are of a type similar to, though simpler than, that of the same teeth in the so-called *Sus scrofa* of the Norfolk Forest Bed. This is of especial interest, for the status of *Sus* in the African fauna is doubtful, the species *S. senaariensis* frequently being regarded as feral *S. scrofa*. The discovery of the fossil species affords some evidence that in earlier times the genus was living in the heart of Africa, and that the distribution was formerly more extensive than at present.

Ruminants are not easy to determine in the absence of satisfactory skulls or horn-cores. The remains from Kaiso and Homa are fragmentary horn-cores and isolated teeth. They all appear to belong to recent genera, but do not allow of specific

Loxodonta antiqua recki.

	Oldoway (Dietrich, 1916)					Homa (Hopwood, 1926a)				*Loxodonta zulu.* Kaiso (Hopwood, 1926b)
	M3	M3	M3	M3	M3	M3	M3	M3	M3	M3
Ridge formula	x15-16x	1-^{2}14x	x14-15x	x15-16x	x13x	x15x	x15x	x^{4}11x	x^{4}11x	x12x
Length	325	305	ca. 280	330	330	295	298	202	206	272
Breadth	ca. 80	74 max.	85	85 (iii)	82	73 (v)	78	77	75 (v)	65
Height	—	130 ca.	ca. 150 (iii)	ca. 150	165	127 (ix)	?	113	126 (x)	108
Lamellar index*	4.9-5.2	5.2-5.6	5.2-5.5	4.85-5.2	4.25	5.4	5.4	5.4	5.3	4.8
Length—Lamella ratio	20	20	18.6	20	22	18.4	18.6	18.4	18.7	21
Length—Breadth ratio*	4	4.1	3.3	3.9	4	4	3.8	?	?	4.2
Enamel thickness	2.5-3	2.8	2.5-3	2+	3	3-3.5	3-3.5	2.5-3	2.5-3	3.5-4
Digitations	1-3-1	1-3-1	1 8 1	—	—	1-3-1	1-3-1	1-3-1	1-3-1	4
Development of figures	← lateral annulus—median lamella →									

* These ratios are not given in Dr. Dietrich's Table (1916, p. 15) but are calculated from his measurements.

determination. Prof. Reck had the good fortune to find at Oldoway a brain-case with horn-cores which he called *Pelorovis oldowayensis*. *Pelorovis* is a large animal, the size of a buffalo, with strongly pneumatic frontal bones. The horn-cores, about 112 cm. long, pass backwards, outwards, downwards, and forwards. Its systematic position is uncertain because the face and dentition have not yet been discovered. Apparently a member of the Ovicaprinae, it has more characters in common with *Ovis* than with *Capra*, but is distinct from both.

Three species of Elephants are known from Central Africa. Two of these are Loxodonts (*L. antiqua recki, L. zulu*); the other is an Archidiskodont (*Archidiskodon* aff. *meridionalis*). At present the fossil elephants of Central Africa, except *L. antiqua recki*, are almost unknown, and the available material does not lend itself to generalizations. From the accompanying table comparisons may be made between the specimens described, but it would not be wise to rely on those comparisons too much. The fragment of *Archidiskodon* from Kaiso is not suitable for detailed study. It has a lamellar index of 4. The mastodont from Nyasaland is indeterminate.

No rodents, insectivores, or edentates, are yet known from the younger beds, and carnivores are very scarce. The only locality from which satisfactory remains of carnivores have been obtained is Oldoway. The specimens were described by Pohle (1928) who found them to comprise scraps of cat and hyaena, *Protocyon recki* n. g. and sp., *Lupulella* (= *Thos*) *mesomelas* var. *latirostris* nov. and *Canis africanus* n. sp. He regards *Protocyon* as the ancestral form of *Otocyon*, and as a descendant of *Nothocyon curvipalatus*. A broader snout palate and choanae serve to distinguish the variety *latirostris* from typical *L. mesomelas*, and the distinction is further emphasized by the shorter, less inflated bulla, and stronger P^4 of the new variety. The new species of *Canis*, *C. africanus*, appears to be in the nature of a provisional species; it does not agree with any of the known species, but, on the other hand, the differences are so slight that Pohle finds it difficult to give a diagnosis.

Two baboons have been found, one at Homa, and one at Oldoway. The former was described by Andrews (1916) as *Simopithecus oswaldi*. Later workers in Germany (Remane, 1925) refer it to *Papio*. It is closely allied to the recent Gelada of Abyssinia, but differs from that species in several details

of varying importance. The specimen from Oldoway was determined by Remane as *Papio* sp.

The human skeleton from Oldoway has not yet been worked out. Andrews (1916) was inclined to doubt its contemporaneity with the remainder of the fauna, and this view, based on the supposed Pliocene age of the beds, has been widely adopted. It is shown below that the age is Pleistocene, probably Middle Pleistocene, and a paper by Prof. Reck (1926) gives the evidence which proves that the skeleton is of the same age as the fossils.

The Older[1] *Fauna.*

I have mentioned above that the faunas described by Andrews and Stromer, and the *Deinotherium* mentioned by Haug, are of earlier date than those just discussed. There are two collections, both undescribed, which afford additional information concerning this earlier group. One of these, in the American Museum, was made by Mr. Herbert Lang, probably in the region that furnished Stromer's material—South West Africa, south of Luderitzbucht. Through the kind offices of Prof. Henry Fairfield Osborn and Dr. Simpson this collection has been lent to me for study and description; to both of these gentlemen I am deeply indebted. The second collection, made in Kenya Colony by Mr. E. J. Wayland, is in the British Museum. More material from the latter locality is being obtained by a small expedition from the British Museum under the leadership of Dr. John Parkinson. In the following paragraphs I deal mainly with the material described by Stromer and Andrews, only referring to the undescribed collections so far as may be necessary to indicate the distribution of some particular species, or to correlate the various deposits.

Rodents appear to have played a large part in the faunas of South West Africa and Kenya. Stromer has described one duplicidentate genus, *Austrolagomys,* a second species occurs in the American Museum collection, and seven simplicidentate genera. Some seven or eight genera and species occur in

[1] A fauna of Miocene age has been described by Fourtau from Moghara in north-western Egypt. It contains *Teleoceras, Aceratherium, Brachyodus, Masritherium, Trilophodon,* a carnivore, and a primate, *Prohylobates.* The anthracotheres and proboscidean link it up with the Karungu fauna, but it has nothing in common with the faunas of Kenya and South West Africa.

Kenya, but none is identical with any of Stromer's forms, nor with *Paraphiomys* from Karungu. The general facies, however, is the same as in South West Africa, and two of the genera are very close to *Diamantomys* and *Pomonomys.*

Austrolagomys is one of the Ochotonidae, and is among the most specialized genera of the family. The premolars especially are more simplified in structure than in any genus known hitherto.

The most interesting of the Simplicidentata is *Parapedetes namaquensis* Stromer. This species was described from eight more or less complete skeletons which were found in a single block of stone, and which were evidently derived from animals which had been buried entire in the flesh. The adults resembled *Pedetes* in outward appearance, and probably, in habits as well. That *Parapedetes* was not so specialized as *Pedetes* is evident from the less inflated ear-region, the unossified external ear-passage, the hard palate, which ends between the first molars, and from the lack of pterygoid fossae. The skeleton and teeth are more simple than they are in *Pedetes.* Important differences between the two genera show that the recent species is not descended from the fossil.

Diamantomys and *Pomonomys* are doubtfully referred to the Theridomyidae. They are of very uncertain affinities, and show no very definite resemblance to any form hitherto described. *Paraphiomys pigotti* Andrews from Karungu appears to have been derived from *Phiomys,* and to belong to the Theridomyidae.

Creodonts are known from South West Africa, and from Kenya Colony. Stromer described a broken skull under the name *Metapterodon kaiseri.* This genus has resemblances to both *Apterodon* and *Pterodon.* Another genus from the same locality was represented by a few isolated bones. An astragalus from Karungu is probably referable to a Creodont of large size. When he wrote, Dr. C. W. Andrews left the matter undecided as to whether the animal was a feline carnivore, or a creodont "surviving in the region after the group had died out elsewhere." From the results of Prof. Stromer's researches, and from unpublished work of my own, I have very little hesitation in assigning the specimen to the Creodonts. There are two, if not three genera in the Kenya deposits, all of them different from *Metapterodon.* One has some resemblance to *Pterodon;* another, represented by P^4, may prove to be an oxyaenid; the third is not easily referable

to any group, it is characterized by its simple, bluntly conical premolars.

True carnivores are only known from Karungu, whence Dr. Andrews described a feline probably nearly related to *Pseudaelurus* or *Aelurictis*. It differs from the latter in the absence of a sharp angulation of the chin, and in one or two features of the premolars. From the former "it is distinguished by the somewhat greater depth of the chin, and the greater length of the diastema between the canine and the second premolar." Dr. Andrews placed it provisionally with *Pseudaelurus* as *P. africanus*.

Remains of Suidae are scarce in all localities. Stromer described *Diamantohyus africanus* from South West Africa, a form which has primitive characters common to the Dicotylinae and to the lower Tertiary pigs of Europe. It does not appear to be closely related to either. Another form he placed near the genus *Propalaeochoerus* Stehlin. A third species, from Kenya Colony, is represented by a single tooth.

Ruminants have been found in each locality. Tragulids resembling *Prodremotherium* and *Dorcatherium* were obtained from Karungu, and others resembling *Prodremotherium* and *Bachitherium* from Kenya. Antelopes are not yet known from Kenya, doubtfully from Karungu, but, from South West Africa, Stromer has described *Propalaeoryx austro-africanus*, and a form which he compares with *Strogulognathus sansaniensis*.

Up to the present Anthracotheres are only known from Karungu. There Dr. Felix Oswald collected some teeth which were described (Andrews, 1914, p. 172) as *Merycops africanus*. Other species were represented by humeri, a femur, part of a tibia, carpals and tarsals. So common were the remains at Karungu that it is not a little curious that the family should not have been detected elsewhere in Central and Southern Africa in beds of approximately the same age.

Hyracoids belonging to the family Myohyracidae were first discovered at Karungu. *Myohyrax oswaldi*, a very small animal with extremely hypsodont molars, is also known from South West Africa. From this locality *Myohyrax doederleini* and *Protypotheroides beetzi* were also obtained. *Protypotheroides* is more specialized than *Myohyrax;* the cheek teeth are fully hypsodont, and the premolars almost completely molariform. The family Hyracidae has not been found among these older faunas otherwhere than in South West Africa.

The species named *Prohyrax tertiarius* by Stromer is a form which is, in some ways, intermediate between the hyracoids of the Egyptian Oligocene, and those which live in Africa at the present time. It is not derived from any of the known older species, nor are any of the younger ones derivable from it.

Proboscidea were discovered to the north of Lake Rudolph, but no description of the remains has yet been published. Haug determined them as *Deinotherium* and figured one of the teeth. From this figure (Haug, 1911, pl. cxxx) it appears that the animal was at least as large as *D. giganteum*. Two species were obtained from Karungu. One of them, *D. hobleyi* Andrews, is known from bones and teeth. The animal was about the same size as *D. cuvieri* but rather more slightly built. The second species was larger than *D. hobleyi*, but was represented in the collection only by the distal end of a tibia. Another tibia from the same beds was tentatively referred by Andrews to a "tetrabelodont." No remains of this group were in the collections on which Stromer worked, and there is nothing definite in the material from Kenya, although one fragment has the appearance of being derived from an accessory cusp of a "tetrabelodont."

THE AGE OF THE FAUNAS.

It is important to determine the age of the beds whence the different collections of fossil mammals have been obtained. Haug termed the deposits to the north of Lake Rudolph "Neogene." There was no other alternative on the evidence at his disposal. In the light of later discoveries, however, I conceive this view to be erroneous. There appear to be two series of beds, the older *Deinotherium* beds, and the younger beds which contained the remainder of the fossils. The *Deinotherium* beds I correlate with the fossiliferous deposits at Karungu, with those in South West Africa, and also with those in the Kenya. Andrews (1916) and Stromer (1926) referred these deposits to the Miocene, Stromer particularizing the age as Lower Miocene. Taking all the evidence into account I see no reason to differ from them.

The persistence of groups which, elsewhere, are characteristic of the Eocene and Oligocene is of great interest, but does not appear to affect the conclusions as to the age of the beds. Andrews' caution with regard to the Creodonts was fully justified in 1916, but when that group is found associated with species common to both Karungu and South West Africa, and

with closely allied genera in both South West Africa and Kenya, there is not the same room for doubt. So long as the evidence was a single bone it might be argued that a mistake had been made in identification, or that the collecting was bad. Such a mistake is not likely to be repeated by other workers dealing independently with widely separated localities. Especially is this the case when more or less complete jaws are available and the determinations are made on well-defined dental characters.

Deinotherium ranges from the Middle Miocene to the Pliocene in Europe and Asia. It is of African origin so that one might reasonably expect to find it at an earlier period in Africa than in Europe. The Creodonts, on the other hand, came of a Holarctic stock and migrated into Africa. They characterize the Palaeocene, Eocene, and Oligocene of Holarctica, but there does not appear to be any reason why they should not persist to a later time in a "backwater" such as Africa. If these two groups, the Proboscideans and the Creodonts, are considered together with the Myohyracidae, *Propalaeoryx,* the Theridomyidae, and the Tragulidae, and the characters of each given full weight, it becomes clear that deposits which contain them as parts of a single fauna can only be of one age, and that Lower Miocene.

The later beds I regard as of Pleistocene age. In earlier papers I have termed them Upper Pliocene, or Lower Pleistocene, a date which I now think to be too early. There is a general resemblance to the fauna of the Val d'Arno and for this reason one is tempted to correlate with that fauna. It now appears that this is a mistake, and that it is not possible to apply the ordinary standards when dealing with the age of Tertiary deposits in Africa. In the following paragraphs I have tried to indicate something of the basis on which this conclusion rests.

Osborn (1915, pp. 223-229) gives a summary of the Pleistocene fauna of North Africa, which included elephants, rhinoceroses, mastodon (in the Lower Pleistocene only), hipparions, asses, zebras, camels, giraffes, bovines, antelopes, pigs, hippopotamuses, lions, hyaenas, jackals, monkeys of northern origin (macaques), a species of deer, a bear of the *Helarctos* group, and wild sheep as well as goats. This series of animals is an enriched variant of the relatively impoverished fauna found in Tropical Africa at the present time. It suggests a fairly warm climate with well-marked dry seasons.

During the Glacial Period, Africa was both cooler and wetter than at present. The periodic advance and retreat of the ice to the northward was reflected in an increase and decrease of the rainfall. This increased rainfall was not without its effect on the vegetation, and much of what is now the Sahara desert was then capable of sustaining a rich and varied fauna. The greater portion of this fauna migrated southward; one of the main routes was along the Great Rift Valley. Later, when the Glacial Period ended, and the rainfall decreased for the last time, desert conditions became established in the Sahara. Except for a very narrow strip along the valley of the Nile, Central and Southern Africa were then isolated from the North, and communication between the two regions was practically at an end.

Apart from a probable increase in dryness and temperature, the conditions in Central Africa were a continuation of those which had just come to an end in the northern part of the continent. The fauna persisted, and the struggle for existence was not greatly intensified. In consequence the primitive forms had a better chance, for the climatic changes were relatively small and there was no competition with more progressive invaders.

The change in climate brought about a change in vegetation. Dryer, warmer conditions meant the development of a type of country to which the term park-land is commonly applied, and the forests became restricted to the wetter regions, notably the belts in the neighborhood of the great rivers and their tributaries. As a result, a large part of the area which, in early Pleistocene times, had been covered by a rank, lush growth, was later covered by harsh wiry grass, and patches of scrub of a more or less xerophytic type. This change, of course, affected the fauna. Animals with low-crowned teeth were at a disadvantage when competing for food against those with high-crowned teeth. The latter were able to utilize the enlarged supply of grasses which were not suitable for the former. An expansion of the park-land at the expense of the forest, and the resultant diminution of the food supply of the browsing animals, partly explains why they died out or became diminished in numbers. At the same time the process was slow, and there is some evidence which shows that it is still going on. Comparison of the reports of travellers, made during the last hundred years, seems to point to a gradual desiccation of northern tropical Africa, and a resultant southward

extension of the desert. But, be that as it may, the slowness of the process since the close of the Glacial Period—the Pluvial Periods of African Geologists—enabled the "early" mammals to live on to a much later time than they did elsewhere.

In my opinion, therefore, the apparently early facies of the later faunas is misleading. There is every reason to believe that forms such as *L. antiqua recki* persisted in Africa long after the European and Asiatic races of the same species had become extinct. The deposits at Kaiso, Oldoway, and elsewhere are not much earlier than the Middle Pleistocene and might even be later.

THE ORIGIN OF THE FAUNAS.

In comparing fossil faunas one with the other, the attempt to separate the indigenous from the immigrant forms is always interesting, often amusing, and sometimes informative. More especially is this the case when the fauna to be examined is only imperfectly known. The Miocene mammals of Central Africa are no exception to this general rule. So much uncertainty exists concerning the origin of certain groups, that one comes to the conclusion that, of the Miocene mammals known from Central Africa, most of the groups are immigrant, and that the Hyracoids, Pedetids, and Proboscideans are the only ones which are indigenous. It is possible that this is true, but, when working with such scanty information, the results are not very reliable, and much additional study will be necessary before anything definite appears.

The following table is based on the information given by Schlosser in the revised (1923) edition of Zittel's "Grundzüge der Paläontologie." It shows the dates of the first appearance of selected groups of mammals in the continental areas of the Northern Hemisphere, and the duration of their existence in those areas up to, and including, the Lower Miocene.

From this table it is evident that, in the present state of our knowledge, very little of the Miocene fauna of Africa can be considered indigenous. Basing themselves on the occurrence of primitive forms in the Bugti (= Upper Gaj) horizon of India (Pilgrim, 1912), some palaeontologists may even wish to exclude the Proboscidea. Careful study of a cast of the fragmentary tooth from that horizon referred to *Moeritherium?*, as well as a cast of the holotype, and original paratype, of *Hemimastodon* shows that the so-called *Moeritherium* is insufficient of itself to prove anything, and that *Hemimastodon*, although only an advanced *Palaeomastodon*, is yet distinctive enough to be placed in a new genus. The Bugti is not older than Upper Oligocene, and is probably Lower Miocene; *Moeritherium* occurs in the Upper Eocene and Lower Oligocene, and *Palaeomastodon* in the Lower Oligocene of Egypt. There is need for more convincing proof before the Asiatic origin of these animals can be accepted, and all that need be said here is that the whole weight of the evidence shows that they are indigenous to Africa.

	Lower Eocene	Middle Eocene	Upper Eocene	Lower Oligocene	Middle Oligocene	Upper Oligocene	Lower Miocene
Ochotonidae					1	1	1, 4
Pedetidae							4
Theridomyidae		1	1	1	1	1	1, 4
Oxyaenidae	1, 2	1, 2	1, 2				4?
Hyaenodontidae	2	1, 2	1, 2	1, 2, 3	1, 2		4
Suidae		1	1	1	1	1, 2	1, 2, 4
Tragulidae				1	1	1	1, 4
Anthracotheriidae		1	1	1, 2, 3	1, 2	1, 2	1, 2, 3, 4
Myohyracidae							4
Hyracidae				3			4
Proboscidea			3	3			1, 3, 4

1. Europe. 2. North America. 3. North Africa. 4. Central Africa.

Nor are conditions different when considering the Pleistocene faunas. The Equines as a group originated outside Africa, and sufficient detail is not yet available to show whether the Zebra is a form which developed in Africa, or whether it came in from outside. *Diceros* is now restricted to Africa, but was widely distributed in the past. The Hippopotamuses appear to have arisen in Asia in the Pliocene, and to have entered Africa at a later date. Pigs of the genus *Sus* are certainly immigrant, but those of the *Hylochoerus, Metridiochoerus, Phacochoerus* group are a type of Suidae which developed in Africa from an immigrant stock, the origin of which is unknown. The hollow-horned ruminants, or Bovidae, probably arose in Europe and spread thence into Asia and from Asia into Africa. Some of them may have gone direct from Europe to Africa at the end of Oligocene, or beginning of Miocene, times (*e.g. Propalaeoryx*). In fact, of the Pleistocene fauna so far known, there appears to be nothing except a

few families, or sub-families, which can be regarded as indigenous to Africa during that period.

The most striking result of this study of the fossil mammal of Central Africa is one which was not wholly unexpected, namely the tendency for groups to persist after they had become extinct elsewhere. The two most notable instances are the Creodonts in the Lower Miocene, and the Hipparions in the Pleistocene. In Eurasia and North America the Creodonts died out in the Oligocene, and the Hipparions in the Pliocene.

CONCLUSION.

In conclusion I wish to express my thanks to Dr. Dietrich and to Profs. Reck and Stromer for their kindness in sending me copies of their papers, and for their helpful and stimulating letters on African palaeontology. To Mr. E. J. Wayland and Dr. Dixey I am indebted for their generosity in sending material home to be worked out, and for the patience with which they allow for the many delays before the final results are ready for publication. Dr. Simpson has been good enough to see this paper through the press, to him also my thanks are due.

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NEW NAMES FOR BRACHIOPOD HOMONYMS.

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As the result of a resurvey of the generic names coined for Brachiopoda since the beginning of the binomial system in 1758, the total is now seen to have reached almost 900 (July 1928). At the time Hall and Clarke began their classic studies, in 1889, there were about 267 of these names in good standing, and when their work was completed, six years later, 58 new genera had been added, making the total then in use 325. The second edition of the Zittel-Eastman text-book (1913) listed about 450 valid brachiopod genera. Now there are about 700.

Of the generic names that are valueless, 101 are straight synonyms, 47 are homonyms, 26 are *incertae sedis* from the days before the rules of nomenclature, 4 are for hypothetic genera, 4 are nomina nuda, and 12 are useless names of other sorts. According to the rules of nomenclature, "A homonym is one and the same name for two or more different things. Synonyms are different names for one and the same thing." Of the 47 homonyms, 23 have been adjusted in the past, leaving 24 more or less unadjusted, and for 12 of these, new names are here proposed, with comments on the other 12.

The new names depart as little as possible from the ones that they replace, just enough, in fact, to hold the names under the rules of zoological nomenclature; and in every instance the genotype is the same as that of the homonym.

Acanthospirina, n. nom., to replace *Acanthospira* Weller 1914 (Geol. Surv. Illinois, Mon. 1, p. 418), not of Reinsch 1877 Prot. Genoholotype: *Spirifera aciculifera* Rowley (as figured by Weller, op. cit., pl. 35, figs. 64-72), of the Lower Carboniferous.

Aulacorhynchus Dittmar 1872. The preoccupation of this name by *Aulacorhynchus* Gould 1834 Aves brings to life *Isogramma* Meek and Worthen 1873 (Geol. Surv. Illinois, vol. 5, p. 568), of the Upper Carboniferous.

Austriellina, n. nom., to replace *Austriella* Bittner 1890 (Abh. geol. Reichs., Wien, vol. 14, p. 314), not of Tenison-Woods 1883 Moll. Genoholotype: *Rhynchonella dilatata* Suess 1855 (Brach. Hallstätt. Schichten, p. 29, pl. 2, fig. 1), of the Triassic.