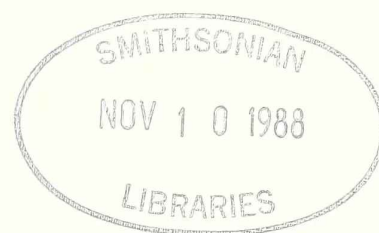


**STRATIGRAPHY AND PALEONTOLOGY OF PLIOCENE AND PLEISTOCENE
LOCALITIES WEST OF LAKE TURKANA, KENYA**

John M. Harris, Frank H. Brown, and Meave G. Leakey



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STRATIGRAPHY AND PALEONTOLOGY OF PLIOCENE AND PLEISTOCENE LOCALITIES WEST OF LAKE TURKANA, KENYA

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ABSTRACT. A cumulative thickness of 730 m of lacustrine, fluvial, and terrestrial sediments exposed near the northwest shoreline of Lake Turkana documents the western margin of the Lake Turkana basin during the late Pliocene and early Pleistocene. These strata constitute the Nachukui Formation, which is named in this paper and subdivided into eight members. The distribution of sedimentary facies within the Nachukui Formation suggests that, as today, the Labur and Murua Rith ranges formed the western margin of the basin and were drained by eastward-flowing rivers that fed into the forerunner of the present lake or a major river system. Twenty-three of the tuffs observed in the formation have been previously recognized from sequences preserved at Koobi Fora and in the lower Omo Valley and permit correlation between these three localities.

Forty-seven fossiliferous sites from West Turkana have yielded more than 1000 specimens of 93 mammalian species, including important *Homo erectus* and *Australopithecus boisei* material that has been reported previously. The larger fossil mammals described in this paper constitute 10 time-successive assemblages that augment information about faunal and environmental change from elsewhere in the basin.

INTRODUCTION

The Lake Turkana basin, which forms part of the eastern Rift Valley system of East Africa, is located at the western edge of the border between Kenya and Ethiopia. It has proved a prolific source of Miocene, Pliocene, and Pleistocene fossils that have contributed much to the understanding of the tempo and mode of evolution of terrestrial African faunas. Within the basin, several geographically discrete areas have at different times been investigated by different research projects (Fig. 1). Pliocene and Pleistocene assemblages of fossil vertebrates and invertebrates from the lower Omo Valley of Ethiopia, to the north of the present lake, were originally documented by Arambourg (1943, 1947) and were later (1967–1974) intensively investigated by participants in the joint French/American International Omo Research Project (Coppens et al., 1976; Coppens and Howell, 1985). The lengthy stratigraphic succession in the lower Omo Valley of southwestern Ethiopia has in consequence provided a framework of radiometric dates and paleomagnetic data from which

to calibrate and interpret faunal change both in the basin and farther afield. The Koobi Fora region, on the northeastern shore of the lake, has been investigated by participants in the Koobi Fora Research Project under the aegis of the National Museums of Kenya since 1968 (Leakey and Leakey, 1978). This region contains a less continuous Pliocene and Pleistocene succession than that documented in the lower Omo Valley, but it both supplements our understanding of the time-sequential regional assemblages of fossil vertebrates and invertebrates in the Lake Turkana Basin, and provides faunal samples from intervals that are either unrecorded or only poorly documented in the latter. The abundant hominid remains (Leakey and Leakey, 1978) have received much attention and some of the other fossil mammals have been described in monographic detail (Harris, 1983). Monographic treatment of the rest of the Koobi Fora fossil material is currently in progress. The localities of Kanapoi, Ekora, and Lothagam to the southwest of the lake have yet to be dated precisely but have yielded assemblages with potential to resolve and document faunal change in the late Miocene and early Pliocene (Patterson et al., 1970; Behrensmeyer, 1976; Smart, 1976; Cooke and Ewer, 1971; Hooijer and Patterson, 1972; Hooijer and Maglio, 1974; Maglio, 1970).

Exposures on the west side of Lake Turkana had previously yielded an early Miocene fauna (Madden, 1972), a Miocene freshwater whale (Mead, 1975), a Cretaceous dinosaur humerus (Arambourg and Wolff, 1969), and fragmentary vertebrate fossils thought to be late Pleistocene or Holocene in age. The region received renewed attention at the beginning of the present decade as an outgrowth of field programs of the Koobi Fora Research Project. The West Turkana Re-

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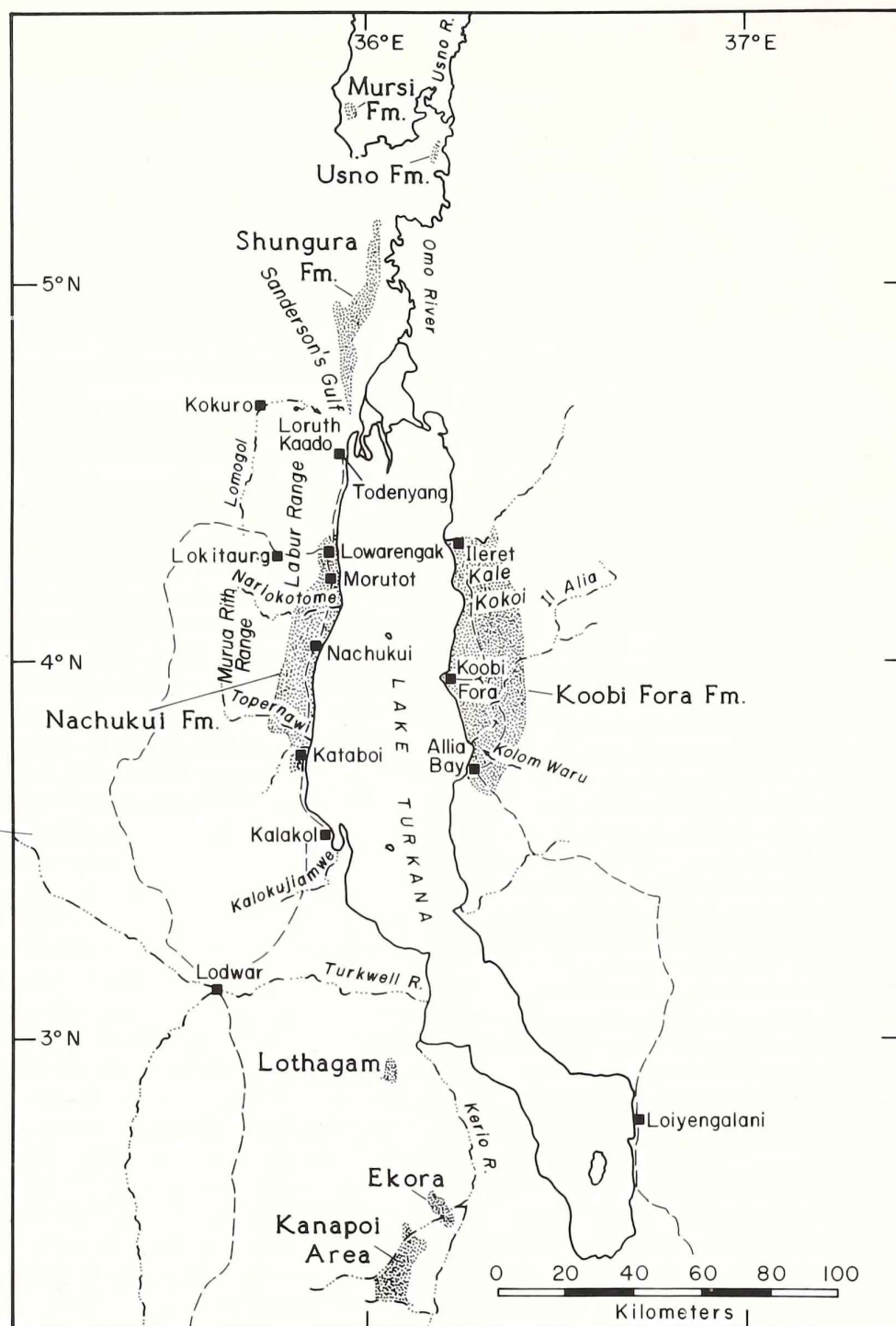


Figure 1. Map of Lake Turkana Basin showing the distribution of the major Plio-Pleistocene fossiliferous localities (West Turkana, Shungura, Mursi, Usno, Koobi Fora, Kanapoi, Ekora, and Lothagam). Shaded areas represent Plio-Pleistocene outcrops. Dashed lines represent roads.

search Project, as it has now become known, is part of the field and research programs of the National Museums of Kenya.

Late in 1980, personnel from the National Museums of Kenya surveyed exposures of the West Turkana region that lay between the settlements of Kalakol (formerly Ferguson's Gulf) and Lowarengak and located sites that contained Pliocene and Pleistocene mammalian fossils and stone tools. These localities were briefly revisited by part of the original team

accompanied by two of us (JMH, FHB) in the summer of 1981 to evaluate the age and diversity of the surface fossils and to seek tuffs for correlation and dating purposes. A further two-week field reconnaissance in the summer of 1982 laid the basis for preliminary estimates of the biostratigraphy and chronostratigraphy of this new area (Harris and Brown, 1985). Large-scale aerial photographic coverage of the region was obtained in 1983 and intensive fieldwork to document the geology and paleontology was initiated in 1984.

One of the objectives of the West Turkana Research Project was to seek additional material relevant to the investigation of early human origins. The subsequent recovery of a virtually complete *Homo erectus* skeleton (Brown et al., 1985) and an early robust australopithecine cranium (Walker et al., 1986) has already been reported. Descriptions of other new hominid material are in progress. The purpose of this paper is to provide additional information on the stratigraphy and paleontology of the Pliocene and Pleistocene strata exposed in this region so that the previously reported hominid specimens can be viewed in terms of their overall chronostratigraphic and biostratigraphic context. Monographic treatment of the Pliocene and Pleistocene fossil assemblages will be provided elsewhere.

GEOGRAPHIC SETTING

The region investigated lies between the settlements of Kalakol to the south and Lowarengak to the north (see Fig. 1), and is largely contained within a strip of land about 10 km wide between the shore of Lake Turkana and low mountains, the Labur and Murua Rith ranges, formed from strata of Miocene or earlier age to the west. Other exposures lie north of the Labur (sometimes spelled "Lapurr") Range near the spring of Loruth Kaado, approximately halfway between the police posts of Kokuro and Todenyang, and also in small patches to the south as far as Kalojujiamwe (Fig. 1). The region is delineated by latitudes 3°35'N and 4°30'N and longitudes 35°40'E and 35°55'E. The elevation of the Pliocene and Pleistocene sediments ranges from about 372 m (the level of Lake Turkana) to 540 m. The top of the Labur Range is the local high point, and rises to 1457 m.

All rivers in the region are ephemeral and drain from west to east. Most arise from the east edge of the Labur and Murua Rith ranges although the larger rivers (the Lagas Topernawi, Kataboi, Kokiselei, and Nariokotome) originate within these ranges. The Lomogol, which rises west of the Labur Range, flows directly northward for most of its course, but turns east at Kokuro to debouch into Sanderson's Gulf. Much of the area is covered by upper Pleistocene and Recent alluvium, but there are many exposures of Pliocene and Pleistocene sediments that crop out along stream courses near the lake or in low hills farther from the lake.

STRATIGRAPHY

Several short articles documenting local sections in the vicinity of fossil hominid remains have been published (Harris and Brown, 1985; Brown et al., 1985; Walker et al., 1986). It was possible to discuss these sections in regional terms because correlations with the Shungura Formation in the lower Omo Valley and with the Koobi Fora Formation east of the lake were established through chemical analysis of volcanic ash layers within the local sections. No generalized account of the stratigraphy of the deposits has been reported previously, nor has a formal stratigraphic nomenclature been established. We here provide a formal stratigraphic scheme for the region.

Even though precise correlations can be made with both

the Shungura and Koobi Fora formations, a new formational name for the geographically separate outcrops along the western side of the lake is justified. Some stratigraphic units from west of Lake Turkana correlate with strata of the Koobi Fora Formation that are absent from the Shungura Formation, whereas others correlate with strata of the Shungura Formation that are absent from the Koobi Fora region. Moreover, a separate name will permit other workers to clearly convey their intent to discuss the fauna, facies, strata, etc. of this particular subregion of the Turkana Basin.

Because lithologic contrasts are extreme in this region, one must opt whether to follow the precedent set for the Shungura and Koobi Fora formations by using volcanic ash layers as marker horizons to define named stratigraphic intervals, or to emphasize observed major changes in sedimentary facies. New units are defined here such that correlation with other established stratigraphic units in the basin is straightforward and precise, hence the earlier precedent is followed, although this is not wholly satisfactory for the geology of this particular part of the basin. It must also be decided whether names applied to subdivisions of the strata should be those applied to other strata exposed elsewhere in the region, or if a new system of subdivisions should be established referring specifically to the strata exposed in the immediate area. A hybrid between the two might be preferable, permitting some members that are lithologically well defined to extend from one formation into another but defining new members where necessary to reflect the unequal development of particular lithologies from one part of the basin to another. Here the third option is followed, defining some new members but retaining other member names that had been previously defined elsewhere.

The widely dispersed nature of the exposures west of Lake Turkana, precludes defining the strata of this region in a single type section. However, each of the members of the formation, as proposed below, can be defined in a single section, and each of these individual sections can be linked by volcanic ash layers. The stratotype of the formation is the composite stratotype of the eight constituent members of the formation.

There are few permanent settlements or prominent topographic features in the region. For this reason discussion of the stratigraphy is made with reference to the unpaved major road linking Kalakol (formerly Ferguson's Gulf) at the south of the area with Lowarengak to the north, and to the ephemeral rivers (lagas) draining eastward into Lake Turkana.

NACHUKUI FORMATION

The name Nachukui Formation is proposed for poorly consolidated sandstones, siltstones, claystones, and conglomerates exposed west of Lake Turkana between 3°20'N and 4°20'N latitude that rest disconformably on, or are in fault contact with, Miocene volcanic rocks and intercalated sediments and/or on Precambrian gneisses. The aggregate thickness of these strata is on the order of 730 m, comparable to that of the Shungura Formation (de Heinzelin, 1983), and of the Koobi Fora Formation (Brown and Feibel, 1986). There is no satisfactory name for the entire region of exposures west of Lake

Turkana, save Turkana itself, but this name has been applied to both Cretaceous and Miocene sediments in the area, and is not available. Consequently the formation is named for an ephemeral stream, the Laga Nachukui, in the vicinity of which outcrops typical of the upper half of the formation are found. The type area of the Nachukui Formation lies west of Lake Turkana, and east of the Labur and Murua Rith ranges (Fig. 1). Exposures of Pliocene and Pleistocene strata immediately to the north of this range near the spring of Loruth Kaado are considered by us to be part of the Nachukui Formation, but are treated separately in this paper. The Nachukui Formation is divided into eight members on the basis of volcanic ash layers of distinctive chemical composition. In ascending stratigraphic order, these members are the Lonyumun, Kataboi, Lomekwi, Lokalalei, Kalochoro, Kaitio, and Nariokotome members. Locations of the type sections of these members are shown on Figure 2.

Tuffs have been used to subdivide the Nachukui Formation into members because they are the only lithologic units that can be recognized with a high degree of confidence wherever they occur in the area. In fact it would be more correct to say that it was possible to create the Nachukui Formation from its constituent members because of the presence of the tuffs. As several tuffs must be newly named here, the sequence of ash layers is discussed before giving descriptions of the members of the Nachukui Formation.

TUFFS OF THE NACHUKUI FORMATION

Much of our understanding of stratigraphic relations between the Shungura, Koobi Fora, and Nachukui formations results from geochemical study of the glass fraction of volcanic ash layers interbedded within these deposits. The gross character of a particular ash layer may change markedly from one area to another within the region—a tuff may be present as a thick channel fill at one locality, but as a thin air-fall deposit at another. Hence one cannot use lithologic characters as a basis for correlation over large areas. The correlations achieved thus far between the three formations rest on compositional data on 1040 glass separates that have been organized into approximately 120 distinct chemical types. Not all tuffs have been found in all areas, and each area has a number of ash layers present only locally. In part this reflects localized deposition and erosion expected in terrestrial settings, and signals that diastems must abound in all sections. Other tuffs, however, are much more widespread, and it is usually possible to place the more geographically restricted tuffs within a reasonably narrow stratigraphic interval with respect to these. In a few cases, however, tuffs of distinctive chemical composition have been collected and analyzed from sections that cannot be related to any of the widespread tuffs. As a result it is not possible to arrange all of the ash layers into a single ordered sequence, although with enough analyses in

enough local sections this is theoretically possible, provided sections linking all ash samples are somewhere preserved in the basin.

Below we summarize information on 43 tuffs within the Nachukui Formation known to be of distinctive chemical composition, or stratigraphically distinct from one another. Some of these are confined to the Nachukui Formation, but others correlate with tuffs exposed elsewhere in the Lake Turkana Basin. For many of tuffs of this latter group two designations already exist—one for tuffs in the Shungura Formation, the other for tuffs in the Koobi Fora Formation. The tuffs of the Shungura Formation have been referred to by an alphanumeric system (de Heinzelin, 1983) rather than names, because the type area of the Shungura Formation has few locally named geographic features that could be used in naming tuffs. This system has been criticized because it does not follow the International Stratigraphic Guide, but for the Shungura Formation the system has proven extremely practical because the designation of the tuff immediately indicates its stratigraphic level. Thus one need not memorize a sequence of names. It seems senseless to name every distinct tuff unless it has been used for stratigraphic subdivision, correlates with an unnamed tuff known elsewhere in the basin, or has been dated. In deference to the “Guide,” and for the sake of uniformity, those tuffs that meet any of the above criteria will be referred to by a name in this paper. If a tuff has been previously named from the Koobi Fora region, that name will be employed here. If no prior name (as opposed to an alphanumeric designation) exists for a tuff it is newly named here. If a tuff has a prior alphanumeric designation, the designation of the Shungura Formation correlative of the named tuff is placed in parentheses immediately following the name throughout the text. Thus Lokochot Tuff (= A) implies that Tuff A of the Shungura Formation is considered correlative with the Lokochot Tuff of the Koobi Fora and Nachukui formations. The tuffs are discussed below in stratigraphic order from the base of the formation upward utilizing the member names stated above. The analyses in Table 1 are arranged stratigraphically insofar as possible, with analyses of the youngest ash layers at the top of the table. Most of the sample locations are shown on Figure 2; a generalized sequence of tephra layers is shown in Figure 3 for reference. Lithologic descriptions of the members are given in the following section.

Only one volcanic ash layer is known from the Lonyumun Member of the Nachukui Formation (K82-721; Table 1). It is 0.5 m thick, lenticular, and lies about 3 m below the Moiti Tuff in a siltstone section exposed in a small ephemeral stream 8 km south of the town of Kataboi.

Seven tuffs are known from the Kataboi Member, five of which correlate with ash layers known elsewhere in the Turkana Basin, or at more distant locales. The Moiti Tuff was defined by Cerling and Brown (1982), and marks the base of

Figure 2. Schematic map of the Nachukui Formation west of Lake Turkana, Kenya. Localities of type sections of members of the formation are shown, as are locations of analyzed tephra samples from the region. Sample numbers are given on the figure without the prefix that designates the year of collection.

Table 1. Compositional data on tuffs of the Nachukui Formation with comparative analyses from the Koobi Fora (KF) and Shungura formations.

Sample #	Fe ₂ O ₃	CaO	K ₂ O	Ba	Mn	Nb	Rb	Sr	Ti	Y	Zn	Zr	Location
Tuffs of the Nariokotome Member													
Kale Tuff													
K81-508	3.00	0.18	2.9	<10	950	99	90	<5	1028	79	153	866	Nakitokonon
K80-143	3.01	0.22	2.5	<10	973	104	94	<5	1080	79	153	874	Area 7, KF
Upper Nariokotome Tuff													
K82-773	4.00	0.22	3.4	376	1510	108	87	<5	1495	91	201	1002	Natoo
Middle Nariokotome Tuff													
K82-772	3.85	0.22	3.1	364	1165	123	89	5	1518	104	221	1081	Natoo
Lower Nariokotome Tuff													
K82-771	4.80	0.18	4.1	87	1892	109	95	26	1770	99	240	1023	Natoo
Tuffs of the Natoo Member													
Unnamed tuff													
K82-769	6.09	0.30	2.7	813	2095	128	79	19	1970	105	166	1134	Natoo
Naito Tuff													
K82-764	5.17	0.24	2.8	622	1714	109	80	14	1654	97	249	1005	Lokapetamoi
ETH329	5.39	0.27	3.3	682	1705	120	81	18	2094	109	240	1101	Naito, Omo
Chari Tuff (= L)													
K82-786	2.90	0.19	2.9	225	696	99	105	6	1105	100	193	1074	Kaitio
77-23	2.81	0.18	3.3	223	564	103	102	5	1093	102	190	1085	Area 1, KF
TEC76-L	2.70	0.18	4.4	225	518	102	107	7	1056	101	183	1106	Kalam; Omo
Unnamed tuff													
K82-785	3.20	0.19	3.1	203	762	114	110	<5	1172	110	213	1155	Kaitio
Unnamed tuff													
K84-2972	1.31	0.29	3.9	1059	488	79	123	203	1440	70	96	302	Nariokotome
Koobi Fora Tuff													
K84-1888	5.01	0.17	2.8	<10	1829	225	142	<5	1886	117	258	1484	Loruth Kaado
K85-2274	5.06	0.19	2.9	<10	1859	239	136	<5	1881	132	276	1665	Area 103, KF
Lower Koobi Fora Tuff													
K84-2957	5.15	0.28	2.5	75	1454	139	108	<5	2054	106	224	1104	Nariokotome
K80-163	5.00	0.37	2.1	35	1485	142	108	12	2064	99	215	1096	Area 103, KF
Tuffs of the Kaitio Member													
Unnamed tuff													
K82-784	6.40	0.19	2.3	<10	2534	312	172	<5	2217	156	353	1994	Kaitio
Morutot Tuff (= J-4)													
K82-766	2.95	0.34	4.2	216	701	147	91	<5	1049	110	201	1005	Natoo
K81-503	2.85	0.33	4.9	168	853	160	97	<5	1049	117	211	1013	Lowarengak
ANU83-32	2.73	0.34	4.9	193	721	153	95	<5	1462	111	207	1022	Area 131, KF
228-3	3.31	0.43	3.5	262	816	141	84	<5	1321	102	196	1176	Ilgwa, Omo
Orange Tuff													
K82-791	2.10	0.40	3.3	<10	421	84	159	10	708	70	90	481	Nachukui
K80-237	2.18	0.46	4.6	39	457	80	145	6	1002	68	83	543	Area 107, KF
Malbe Tuff (= H-4)													
K81-514	4.76	0.91	2.5	51	1858	158	99	20	3240	99	210	1121	Nachukui
K80-225	4.70	0.38	3.0	61	1897	139	103	<5	3353	82	194	996	Area 112, KF
76-H4B	4.78	0.34	4.3	253	1934	152	119	16	3067	95	212	1082	Shungura, Omo
KBS Tuff (= H-2)													
K82-775	3.05	0.18	3.3	27	869	196	172	<5	1178	129	227	1233	Kaitio
77-17	3.09	0.23	3.2	30	843	194	165	7	1297	129	253	1239	Area 105, KF
76-H2B	3.00	0.17	3.8	89	825	191	174	7	1205	131	230	1319	Shungura, Omo

Table 1. Continued.

Sample #	Fe ₂ O ₃	CaO	K ₂ O	Ba	Mn	Nb	Rb	Sr	Ti	Y	Zn	Zr	Location
Tuffs of the Kalochoro Member													
Kangaki Tuff													
K82-739	3.60	0.16	2.3	11	1523	204	170	<5	1318	104	209	1535	Kangaki
Unnamed Tuff													
K82-738	6.19	0.19	1.7	54	2512	226	226	69	1175	134	260	1632	Kangaki
K82-741	6.32	0.18	1.1	<10	1805	250	80	<5	1116	151	262	1689	Kokiselei
Unnamed Tuff													
K82-740	4.75	0.20	1.5	<10	1736	192	104	<5	1796	110	216	1423	Kokiselei
K82-737	4.70	0.21	2.1	19	1681	198	81	<5	1858	111	223	1449	Kokiselei
Unnamed Tuff													
K84-1849	6.18	0.22	1.4	<10	2260	407	72	8	1446	236	393	3007	Kalochoro
Ekalalei Tuff (= F-1)													
K85-2614	4.75	0.21	1.2	<10	1772	203	117	<5	1807	119	217	1479	Lokalalei
K86-3022	4.43				1711	196	90	<5		108		1409	Nachukui
ETH-228	4.67	0.21	1.9	12	1606	188	73	11	1593	104	215	1377	Shungura, Omo
Kalochoro Tuff (= F)													
ET-51	4.63	0.18	2.0	<10	1514	169	95	<5	1537	129	272	1394	Shungura, Omo
K84-1848	4.57	0.19	1.6	<10	1517	179	107	<5	1781	134	273	1476	Kalochoro
ET-53	4.77	0.18	1.8	<10	1542	192	91	<5	1469	146	272	1638	Shungura, Omo
Tuffs of the Lokalalei Member													
Unnamed tuff													
K82-780	2.36	0.29	2.4	509	1290	109	112	10	1913	82	140	854	Kaitio
Nalukuwoi Tuff (= E-4)													
K82-779	4.30	0.19	2.0	<10	1447	152	103	<5	1504	111	223	1213	Kaitio
K85-2662	4.36	0.22	1.1	<10	1478	150	93	<5	1516	114	215	1237	Lomekwi
ET-103	4.67	0.16	2.6	<10	1583	147	104	<5	2001	105	206	1246	Shungura, Omo
Unnamed tuff													
K82-777	4.95	0.19	2.0	16	1706	147	83	<5	2145	101	210	1185	Kaitio
Kokiselei Tuff (= E)													
K85-2615	6.10	0.22	1.2	29	2406	172	107	<5	2249	130	261	1359	Lokalalei
ET-45	6.11	0.20	1.5	<10	2402	168	72	<5	2276	128	279	1338	Shungura, Omo
Unnamed tuff													
K82-729	5.90	0.13	1.1	<10	2058	354	109	<5	1368	214	362	2813	Lomekwi
Unnamed tuff													
K85-2654	3.13	0.37	1.8	117	1559	74	65	12	3213	64	136	557	Lomekwi
Lokalalei Tuff (= D)													
K84-2934	3.45	0.19	1.8	<10	1337	179	151	<5	1333	102	178	1414	Lokalalei
K82-2635	3.12	0.14	1.5	<10	1429	171	117	5	1708	99	168	1332	Kangatukuseo
ET-35	3.15	0.12	3.7	<10	1240	174	154	<5	1304	95	165	1321	Shungura, Omo
80-275	3.58	0.15	1.7	<10	1388	169	159	<5	1384	95	201	1233	Area 207, KF
K82-2657	3.41	0.19	2.2	<10	1327	161	140	<5	1579	88	153	1169	Lomekwi
Tuffs of the Lomekwi Member													
Unnamed tuff													
K85-2652	2.69	0.19	1.8	10	1301	101	90	<5	2141	74	134	816	Lomekwi
Emekwi Tuff (= C-9)													
K82-2674	5.19	0.22	1.2	<10	1834	193	116	<5	1871	112	261	1382	Lokalalei
ET-77	5.11	0.18	2.0	<10	1782	197	80	<5	1847	114	249	1417	Shungura, Omo
Waru Tuff													
K85-2604	5.28	0.25	1.9	<10	1674	109	109	<5	1945	120	209	1006	Topernawi
K82-1372	5.29	0.23	2.0	11	1640	106	125	<5	1819	116	206	972	Area 207, KF

Table 1. Continued.

Sample #	Fe ₂ O ₃	CaO	K ₂ O	Ba	Mn	Nb	Rb	Sr	Ti	Y	Zn	Zr	Location
Unnamed tuff													
K82-750	3.59	0.11	3.0	10	990	206	243	<5	907	147	314	1666	Loruth Kaado
Tulu Bor- β Tuff (= B β)													
K85-2598	1.66	0.35	3.3	177	459	81	118	7	940	59	76	381	Nasechebun
K80-177	1.56	0.31	3.3	134	392	85	115	5	962	63	73	386	Area 117, KF
ET-89	1.62	0.29	3.5	114	372	85	132	6	874	64	73	367	Shungura, Omo
Tulu Bor- α Tuff (= B α)													
K85-2597	1.39	0.49	3.4	413	278	75	121	27	1214	55	55	283	Nasechebun
K81-479	1.37	0.47	4.3	399	248	72	114	22	1196	52	59	266	Area 250, KF
Tuff B α	1.41	0.55	3.2	416	283	75	148	33	1364	55	55	288	Shungura, Omo
Tuffs of the Kataboi Member													
Kaado Tuff													
K84-1874	2.53	0.32	3.5	18	984	94	70	<5	1814	70	128	816	Loruth Kaado
K84-1584	2.68	0.23	3.0	38	1170	97	62	6	2095	73	178	796	Area 117, KF
Lokochot Tuff (= A)													
K81-532	3.59	0.18	2.8	103	806	146	127	5	1209	133	244	1369	Nasechebun
K80-291	3.51	0.18	3.3	121	809	146	126	<5	1233	135	233	1360	Area 250, KF
Tuff A	3.70	0.21	3.1	109	828	153	132	7	1285	140	255	1419	Shungura, Omo
Loruth Tuff													
K82-746	2.87	0.44	3.9	19	598	87	150	16	1407	69	132	683	Loruth Kaado
K81-481	2.91	0.36	3.1	<10	572	78	146	<5	1086	68	131	673	Area 250, KF
Unnamed tuff													
K85-2860	3.32	0.18	2.4	893	898	108	80	33	1634	94	132	833	Topernawi
Unnamed tuff													
K82-742	4.40	0.21	2.5	<10	1533	161	143	<5	1581	110	204	1136	Loruth Kaado
Topernawi Tuff													
K85-2709	2.81	0.20	3.3	<10	828	139	158	<5	1118	99	142	918	Lomekwi
K85-2726	2.45	0.46	3.9	137	1092	101	118	8	2194	71	123	778	Area 254, KF
Moiti Tuff													
K85-2594	2.80	0.24	3.0	395	695	117	95	11	1186	112	227	1058	Nasechebun
K81-602	2.70	0.18	4.2	401	618	122	97	<5	1063	114	235	1099	Area 260, KF
Tuff of the Lonyumun Member													
Unnamed Tuff													
K82-721	4.26	0.30	2.0	14	1296	115	89	<5	1627	95	174	1030	S of Kataboi

the Kataboi Member. It is an extremely widespread ash layer, known from the Koobi Fora and Nachukui formations in the Turkana Basin, from the deep sea in the Gulf of Aden (Sarna-Wojcicki et al., 1985), the Somali Basin (unpublished data), and the region between North Horr and Loiyengalani on the western edge of the Chalbi Desert (Brown et al., in prep.). A similar ash has been reported in the upper part of the Omo River valley by W[olde]-Gabriel and Aronson (1987), where it is much thicker than in the Turkana Basin. In the Nachukui Formation, the Moiti Tuff is discontinuously exposed from Topernawi southward to Kalokujiamwe. It has been dated at 4.10 ± 0.07 Ma by McDougall (1985).

A thick sandstone between Laga Topernawi and the upper course of the northern branch of Lomekwi contains a tuffaceous band 3–5 m above its base with pumice clasts up to

10 cm in maximum dimension. This tuff is here named the Topernawi Tuff, with its type locality in the Lomekwi drainage (sample K86-2709; Fig. 2). It is probable that this tuff correlates with a tuff that demonstrably lies between the Moiti and Lokochot (= A) tuffs of the Koobi Fora Formation in Area 254 of the Koobi Fora region. There it consists of a coarse ash with well-developed current cross-bedding, and is obviously reworked. K/Ar determinations on this tuff are consistent with its position, and will be reported elsewhere (Feibel, Brown, and McDougall, in prep.) along with supporting data.

Two tuffs (K82-742 and K85-2860) are known only from the Nachukui Formation, and are not named here. K82-742 is a lenticular tuff that lies about 10 m below the Lokochot Tuff (= A) at Loruth Kaado. K85-2860 is a sample of a lenticular tuff known only where it fills a channel to a depth

of 7.8 m in exposures between the Laga Kataboi and the Laga Topernawi. There it lies 9 m below the Lokochot Tuff (= A), but disappears laterally. The relative order of these two tephra layers is not known with certainty.

A second section of Loruth Kaado includes a vitric tuff (K82-746) 0.5 m thick which lies 2 m below the Lokochot Tuff (= A). It correlates with a tuff (K81-481) exposed in Area 250 at Koobi Fora where it lies 4 m below the Lokochot Tuff (= A). This tuff is here named the Loruth Tuff; the type locality is the exposure at Loruth Kaado.

The Lokochot Tuff (= A) was defined by Cerling and Brown (1982) in the Koobi Fora Formation. It was described in that paper, and it was also demonstrated that Tuff A of the Shungura Formation is its lateral equivalent. Subsequently it was found that the Lokochot Tuff (= A) is present in deep-sea sediments of the Gulf of Aden (Sarna-Wojcicki et al., 1985), and in Pliocene exposures located south of Lothagam (Brown et al., 1985). In the Nachukui Formation the Lokochot Tuff (= A) is discontinuously exposed from Kokiselei to Nasechebun (see Table 1).

Below the Tulu Bor Tuff (= B) at Loruth Kaado is a vitric tuff (K84-1874) 12 m thick, which we name here the Kaado Tuff, after the type locality at Loruth Kaado. It is separated from the Tulu Bor Tuff by 2.7 m of olive-gray claystone. Compositionally it is very similar to a tuff (K83-1584) exposed in an isolated section in Area 117 at Koobi Fora, and correlation between these two units is probable. This is the highest volcanic ash layer known in the Kataboi Member of the Nachukui Formation.

Six tephra layers are known from the Lomekwi Member. The lowest two of these are the two types of Tulu Bor Tuff (= B) designated α -Tulu Bor (= B α) and β -Tulu Bor (= B β) tuffs by Cerling and Brown (1982), where it was also shown that the Tulu Bor tuffs (= B) correlate with Tuffs B- α and B- β of the Shungura Formation. Comparative analyses are given in Table 1. In the Nachukui Formation the Tulu Bor Tuffs are known from Loruth Kaado, and from exposures between Lomekwi and Nasechebun. The β -Tulu Bor Tuff has been correlated with the Sidi Hakoma Tuff of the Hadar Formation in Ethiopia by Brown (1982), and has been identified in deep-sea sediments of the Gulf of Aden (Sarna-Wojcicki et al., 1985). An unnamed tuff (K82-750) exposed at Loruth Kaado lies about 2 m above the Tulu Bor Tuff there. This is its only known occurrence.

A fine sand section on the south bank of the lagoon Topernawi 5 km west of the road contains a tuffaceous interval, glass shards from which (K85-2604) are compositionally identical to those from a tuff (K82-1372) cropping out in Area 207 of the Koobi Fora region (Brown and Feibel, 1986). This tuff lies 5 m stratigraphically above the base of the Allia Tuff, and is here named the Waru Tuff, after Kolom Waru, a small stream in the Allia Bay region at Koobi Fora. In its type section the Waru Tuff is 8–10 cm thick, unbedded, and composed predominantly of flat and bubble-junction shards.

The Emekwi Tuff (= C-9), newly named here (see below), is exposed only in the southern branch of the Laga Lokalalei, where it is a medium to dark gray vitric tuff 1 m thick with small-scale cross-laminations (sample K82-2674). It rapidly

NACHUKUI FORMATION	
NARIOKOTOME MEMBER	vvvvvvvvv---KALE TUFF
	vvvvvvvvv---UPPER NARIOKOTOME TUFF
	vvvvvvvvv---MIDDLE NARIOKOTOME TUFF
	vvvvvvvvv---LOWER NARIOKOTOME TUFF
NATOO MEMBER	vvvvvvvvvv---K82-769
	vvvvvvvvvv---NAITO TUFF (=L-3)
	vvvvvvvvvv---CHARI TUFF (=L)
	vvvvvvvvvv---K82-785
KAITIO MEMBER	vvvvvvvvvv---K84-2792
	vvvvvvvvv---KOobi FORA TUFF
	vvvvvvvvv---LOWER KOobi FORA TUFF
	vvvvvvvvvv---K82-784
KALOCHORO MEMBER	vvvvvvvvvv---MORUTOT TUFF (=J-4)
	vvvvvvvvv---ORANGE TUFF
	vvvvvvvvvv---MALBE TUFF (=H-4)
	vvvvvvvvvv---KBS TUFF (= H-2)
LOKALALEI MEMBER	vvvvvvvvvv---KANGAKI TUFF
	vvvvvvvvvv---K82-738
	vvvvvvvvvv---K82-737
	vvvvvvvvvv---K84-1849
LOMEKWI MEMBER	vvvvvvvvvv---EKALALEI TUFF (=F-1)
	vvvvvvvvv---KALOCHORO TUFF (=F)
	vvvvvvvvvv---K82-780
	vvvvvvvvvv---NALUKUWOI TUFF (=E-4)
KATABOI MEMBER	vvvvvvvvvv---K82-777
	vvvvvvvvvv---KOKISELEI TUFF (=E)
	vvvvvvvvvv---K82-729
	vvvvvvvvvv---K85-2654
LONYUMUN MEMBER	vvvvvvvvvv---LOKALALEI TUFF (= D)
	vvvvvvvvvv---K85-2652
	vvvvvvvvvv---EMEKWI TUFF (=C-9)
	vvvvvvvvvv---WARU TUFF
LOKALALEI MEMBER	vvvvvvvvvv---K82-750
	vvvvvvvvvv--- β -TULU BOR TUFF (=B β)
	vvvvvvvvvv--- α -TULU BOR TUFF (=B α)
	vvvvvvvvv---KAADO TUFF
KALOCHORO MEMBER	vvvvvvvvvv---LOKOTHOT TUFF (=A)
	vvvvvvvvvv---LORUTH TUFF
	vvvvvvvvvv---K85-2860
	vvvvvvvvvv---K82-742
LOKALALEI MEMBER	vvvvvvvvv---TOPERNAWI TUFF
	vvvvvvvvv---MOITI TUFF
LOKALALEI MEMBER	vvvvvvvvvv---K82-721

Figure 3. Schematic section through the Nachukui Formation showing the sequence of analyzed tuffs.

thins laterally to 30 cm. There is little question that it correlates with one of the tuffs of Submember C-9 of the Shungura Formation (see Table 1). Five meters above it, along the southern branch of the Laga Lokalalei lies another thin unnamed tuff of distinctive composition (K85-2652) that is widely exposed near the top of the section at Lomekwi. This latter tuff lies 4 m below the Lokalalei Tuff (= D) along Laga Lokalalei.

At exposures adjacent to the Lokalalei drainage there is a 30-cm-thick vitric tuff that crops out discontinuously as far south as the Laga Kangatukuseo. It is quite variable in gross character. At Lokalalei it was deposited over a dark brown claystone, and is massive. At Lomekwi it was deposited and redeposited over an interval of about 6 m of section in channels commonly with *Etheria* at the base. There it contains lenses of pumice gravel with clasts up to 20 cm in diameter. This tuff is compositionally indistinguishable from Tuff D of the Shungura Formation, and is here named the Lokalalei Tuff (= D). Partial chemical analyses of this tuff have been published previously by Harris and Brown (1985). It also correlates with the informally designated "upper Burgi Tuff" of Cerling and Brown (1982), and the name Lokalalei Tuff should now be applied to that tuff (see Table 1). The best age estimate for this tuff based on K/Ar determinations is 2.52 ± 0.05 Ma (Brown et al., 1985). Nine meters above the Lokalalei Tuff at Lomekwi is an unnamed vitric tuff 0.7 m thick that is known only from this locality (sample K85-2654).

About 18 m above the Lokalalei Tuff at Lokalalei is another vitric tuff composed of distinctive dark gray glass shards. This tuff is compositionally indistinguishable from Tuff E of the Shungura Formation, and is here named the Kokiselei Tuff (= E). The Kokiselei Tuff is discontinuously exposed from Kaitio to Lomekwi in the Nachukui Formation.

Above the Kokiselei Tuff along the Laga Kaitio near the lake there are three tuffs (samples K82-777, -779, and -780; Table 1) that lie 7 m, 15 m, and 22 m, respectively, above the Kokiselei Tuff (= E) in the upper Lokalalei Member. K82-779 (the middle one of the three) correlates with a tuff in Submember E-4 of the Shungura Formation, and is here named the Nalukuwoi Tuff, after the laga of that name immediately south of Laga Kaitio. The Nalukuwoi Tuff is also known from the northern part of the Lomekwi drainage (sample K85-2662). The other two tuffs are not named as they are known only from this locality.

Six tephra layers are known from the Kalochoro Member. The lowest of these is the Kalochoro Tuff (= F). This tuff is 1.4–1.7 m thick, and contains pumice clasts up to 3 cm in diameter. It is compositionally indistinguishable from Tuff F of the Shungura Formation. Its reference locality in the Nachukui Formation is the exposure along the Laga Kalochoro, but it is also exposed on the north bank of the Laga Nachukui at the road crossing. Tuff F of the Shungura Formation has been dated at 2.35 ± 0.05 Ma by Brown et al. (1985).

Approximately 4 m above the Kalochoro Tuff on the south bank of the Laga Nachukui is another tuff that is compositionally very similar to the Kalochoro Tuff, but distinct. This

tuff correlates with Tuff F-1 of the Shungura Formation, and is here named the Ekalalei Tuff (= F-1). The type locality is taken as the section at Lokalalei where the type section of the Lokalalei Member was measured (see Fig. 8).

About 8 m above the Kalochoro Tuff at its type locality is another tuff (K84-1849). This tuff is lenticular, and its thickness ranges from 0 to 5.5 m where exposed along the Laga Kalochoro. There it is small-scale cross-laminated and contains abundant calcified root casts. A possible correlate is found at Lokalalei; this tephra layer remains unnamed.

Three other tuffs belong to the Kalochoro Member, only the uppermost of which is named. These tuffs are exposed only along the Laga Kalochoro and Kangaki. Analyses are given in Table 1 (see uppermost tuffs of Kalochoro Member). The uppermost is here named the Kangaki Tuff. It contains pumice clasts that may prove datable. The type locality of this tuff is along the Laga Kangaki, where it is a very pale gray, fine-grained tuff 2.4 m thick (see Fig. 2).

Five tuffs are known from the Kaitio Member, four of which correlate with tephra layers elsewhere in the basin. The KBS (= H-2) and Malbe (= H-4) Tuffs are well known, and need little discussion (see Cerling and Brown, 1982). In most exposures in the Nachukui Formation they are altered to clay. The KBS (= H-2) and Malbe (= H-4) tuffs are very securely dated at 1.88 ± 0.02 , and 1.87 ± 0.02 Ma by McDougall (1985).

The Orange Tuff has been referred to informally as such since Bowen discovered it in Area 131 at Koobi Fora. In subsequent work it was identified in Area 107 at Koobi Fora, and also exists in the upper part of the Nachukui drainage in the Nachukui Formation (K82-791). We here formally name it the Orange Tuff because in its type area (Area 131, Koobi Fora) it is orange.

A thick tuff (5 m) is well exposed at Nanyangakipi, at Lowarengak, and at Natoo, and is very useful as a mapping unit in this area. This tuff is composed of coarse bubble junction and striated glass shards, and at Nanyangakipi it contains occasional pumice clasts up to 8 cm in diameter. It is compositionally similar to Tuff J-4 of the Shungura Formation, and is here named the Morutot Tuff (= J-4), with the type area specified as Nanyangakipi. Pumices whose chemical composition match that of the Morutot Tuff (= J-4) (Brown and Feibel, 1985) have been dated at 1.65 ± 0.02 by McDougall et al. (1985).

The highest tuff assigned to the Kaitio Member is an unnamed tuff (K82-784) that lies only 5 m below the Lower Koobi Fora Tuff along the Laga Kaitio. It is only 10 cm thick, and appears massive. It is known only from this exposure and from exposures along the Laga Kalochoro.

The basal tuff of the Natoo Member is the Lower Koobi Fora Tuff, defined by Brown and Feibel (1985). Six additional tuffs have been analyzed from the Natoo Member, only two of which are known elsewhere in the Turkana Basin. The lowest of these is likely the Koobi Fora Tuff (see Brown and Feibel, 1985), and is known only from Loruth Kaado in low outcrops east of the road there.

An unnamed, but very distinctive tuff (K84-2972) is locally useful from Nariokotome to Kalochoro where it outcrops

discontinuously. It lies 7 m above the Lower Koobi Fora Tuff at the road crossing on the Laga Nariokotome. There it is 1.3 m thick and contains sparse mollusks near its base. It is essentially the same composition as the Tulu Bor Tuff, with which it could be confused in the absence of analyses of other tuffs related stratigraphically to it, or other information concerning its age. K82-735 is a sample of an unnamed vitric tuff that lies 35 m below the Chari Tuff in exposures along Laga Kaitio. It is 5 cm thick and known only from this locality.

The Chari Tuff (= L) is well known; a definitive description was given by Cerling and Brown (1982). It is known to correlate with Tuff L of the Shungura Formation, and thus far has only been identified at two localities in the Nachukui Formation—along the Laga Nariokotome and along the Laga Kaitio. In the latter locality it contains pumice clasts to 20 cm although the ash layer itself is only 10 cm thick. The Chari Tuff has been very securely dated at 1.39 ± 0.01 Ma by McDougall (1985).

The Naito Tuff (L-3), named here, is the highest tuff known from the Kaitio Member. It correlates with a tuff that lies 9 m above Tuff L in the Shungura Formation, and has been ascribed to Submember L-3 of the Shungura Formation by de Heinzelin (1983). The type locality is taken as Naito, a regional name for low hills about 3 km NNW of Namaruputh in Ethiopia near the southern extent of the Shungura Formation. In the Nachukui Formation it is thus far known only as a very pure ash layer 20 cm thick at Lokapetamoi where it lies 3 m below the Lower Nariokotome Tuff (see below).

On the south bank of Nariokotome, 0.5 km west of the road crossing, there is a cliff which exposes a siltstone sequence that contains two tuffs in a section about 10 m thick called the Nariokotome Tuff complex. The basal tuff in this sequence is named the Lower Nariokotome Tuff. It is 24 cm thick, poorly consolidated, composed of bubble-junction and bubble-wall shards, contains rounded pumice clasts up to 20 cm in diameter, and grades upward from very coarse grained ash to fine-grained ash. Locally it is a very useful marker bed. Along Laga Natoo the Nariokotome Tuff Complex is only 7 m thick, but here three thin vitric tuffs are found in sequence. The central tuff is here named the Middle Nariokotome Tuff. It is 8 cm thick, but otherwise similar to the Lower Nariokotome Tuff. A third vitric tuff lies at the top of the complex, is again similar to the two underlying tuffs in overall aspect, but is 10 cm thick, and is here named the Upper Nariokotome Tuff. These tuffs are compositionally only slightly distinct from one another, but sufficiently so that they cannot be confused if only one is present. The sediments which intervene between the tuffs are tuffaceous fine sandstones and siltstones that are distinctly laminated and contain fish bones and carbonate concretions. Near the divide between the northern branch of Laga Nachukui and Laga Nariokotome, the Lower Nariokotome Tuff occurs in a conglomeratic section where it contains accretionary lapilli 5 mm in diameter throughout its 1-m thickness. The Lower Nariokotome Tuff has been dated at 1.33 ± 0.05 Ma; K/Ar measurements are reported in Brown et al. (1985).

At Kaieri Akak and at Nakitokonon, strata assigned to the

Nariokotome Member are also present. At both localities exposures are poor, but both contain a tuff which correlates with a tuff that lies stratigraphically above the Silbo Tuff of the Koobi Fora Formation in the Ileret Area. This tuff is named the Kale Tuff after the large plain north of Koobi Fora Area 7, which is its type area. Although the Kale Tuff has not been dated, it should be only slightly younger than the Silbo Tuff. The Silbo Tuff has been dated at 0.74 ± 0.01 Ma by McDougall (1985).

Correlations from the Nachukui Formation to the Shungura and Koobi Fora formations (Fig. 4) provide a reasonably tight framework in which to interpret the vertebrate faunas from the three formations. The correlations are also useful in comparing lithostratigraphic differences from narrow temporal intervals which is necessary for paleogeographic reconstructions.

DESCRIPTIONS OF MEMBERS

Lonyumun Member

The Lonyumun Member of the Nachukui Formation comprises those sediments that lie below the basal contact of the Moiti Tuff. This member is best exposed in the southern part of the region west of Lake Turkana in the Nasechebun drainage south of Kataboi. Other excellent exposures lie near the contact with Miocene volcanic rocks in the northern part of the region. The member as defined is stratigraphically equivalent to the Lonyumun Member of the Koobi Fora Formation (Brown and Feibel, 1986), hence that name is retained. In its reference section in the Nachukui Formation it is 91 m thick (Fig. 5).

The Lonyumun Member is lithologically very similar to its counterpart in the Koobi Fora Formation, but is somewhat thicker west of the lake. The basal contact is only locally seen, but at the Nasechebun drainage the member rests on basalt. The lowest part of the section consists of dark brown to pale olive laminated claystones that contain ostracods and mollusks. Sparse interbeds of sandstone a few centimeters thick are normally limonite-stained, and contain both fish bones and ostracods. Diatomites occur higher in the section near the top of the member, but are also locally present much lower in the section. In the exposures along Laga Lomekwi, limonite-stained volcanic conglomerates with weathered clasts interfinger with the claystones and diatomites near the base of the section. The upper contact of the Lonyumun Member is marked by a thin altered tuff in the upper part of the northern branch of the Laga Lomekwi. As no fresh glass remains, this altered tuff could not be chemically compared to the type Moiti Tuff of the Koobi Fora Formation but its correlation is believed to be secure. Where the Moiti Tuff crops out in the Topernawi drainage and south of Kataboi, it has been positively correlated with that from the type locality at Koobi Fora.

Other small exposures of the Lonyumun Member are found along the mountain front as far south as the Laga Kalokujiamwe. The member may extend much farther south, however, because strata of the Murungori Formation (Powers,

Equid specimen lists and measurements (continued).

Equus sp. dental measurements (continued)									
	14668	17426	17454	17499	16078	14744	14673	16094	14694
P ² ap		40.7				40.7			
tr		24.6				25.0			
P ³ ap		30.2		30.7					
tr	28.3	27.4		26.6					
P ⁴ ap		30.2							
tr		28.4							
M ¹ ap		25.9							
tr		25.8							
M ² ap		27.4							
tr		27.0							
M ³ ap		26.7	27.1		23.0		26.0	26.5	26.1
tr		23.3	22.4		20.5		28.4	22.8	22.8
	14682	16054	14688	14679	14681	14690	14691	14693	
P ² ap				40.7					
tr				28.0					
P ^{3/4} ap	29.2	31.9	27.4	29.7	29.7	24.8			
tr	—	—	25.9	31.1	—	25.4			
M ^{1/2} ap	23.1			23.2	25.8		23.9	26.3	
tr	—			—	25.4		23.8	26.8	
M ³ ap				29.6					
tr				28.4					
Equidae indet.									
Material referred				Material referred					
KNM-WT	Specimen		Site	KNM-WT		Specimen		Site	
16088	dist R radius		LO8	14671		R dist tibia		KL3	
14683	dist R radius		KL1	14687		dist L tibia		KK	
16048	terminal phalanx		KL1	17453		cranial frag		KL1	
14678	proximal phalanx		NN	17459		radius frags		KL1	

species of *Equus* that have been previously recognized from elsewhere in the Lake Turkana Basin is a task which will be deferred until more complete material is available for study.

Equus species indeterminate

Figure 34

The 36 *Equus* specimens from the Kalocho, Kaitio, Natoo, and Nariokotome members appear to represent only a single species, though which one is open to question. The common *Equus* species from Koobi Fora was *E. koobiforensis* according to Eisenmann (1983), but the relationship of the latter to *E. oldowayensis* has yet to be clarified. Hooijer and Churcher (1985) attributed all the *Equus* specimens from the Omo succession to *E. oldowayensis*. Eisenmann (1985), wary of the great variation in size and proportions of postcranial material referred to the latter taxon, instead identified *Equus numidicus* and *E. stenonis vireti* from Shungura Member G and Grevy's zebra (*E. grevyi*) from the upper part of Member L. Unfortunately neither Eisenmann nor Hooijer and

Churcher attempted comparisons of the Omo material with that from Koobi Fora.

Equidae Indeterminate

In addition to the specimens described above there are a number of postcranial elements that have not at present been identified to genus.

Family Rhinocerotidae

The two extant genera of African rhinos are represented in the West Turkana sequence. Of the two, the remains of *Diceros* are less common and are indistinguishable from representatives of the extant species.

Diceros Gray, 1821

Diceros bicornis (Linn., 1758)

The extant black rhinoceros is a conservative species that appeared as long ago as 3.5 Ma in the Upper Laetoli Beds

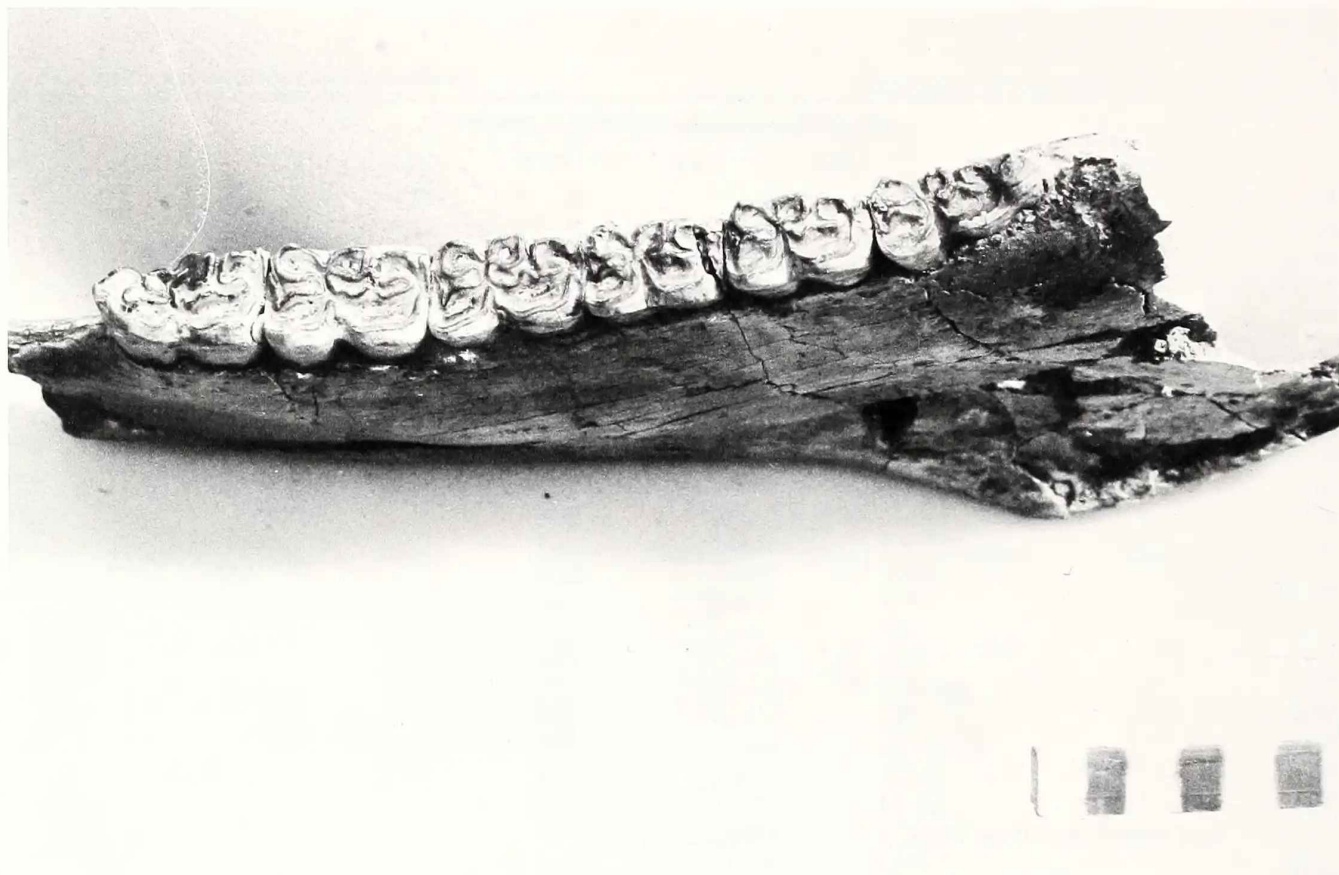


Figure 34. KNM-WT 14686, *Equus* sp. indet. left mandible fragment (P₂–M₃) from the Kalochoro Member at KK; occlusal view.

(Guerin, 1987). *Diceros bicornis* has been retrieved only from the upper Burgi and KBS members of the Koobi Fora Formation (Harris, 1983:139) but in the Shungura succession is represented in the Mursi and Usno formations and in all members of the Shungura Formation except Member E (Guerin, 1985; Hooijer and Churcher, 1985).

The black rhino is represented at West Turkana in the Lomekwi, Kaitio, and Nariokotome members. The 10 specimens include the occipital region of a cranium (WT 16731) from LO3, the proximal portion of a third metacarpal (WT 14501) from NC2, and eight other isolated teeth or partial dentitions. The occiput has a width of 205 mm at the mastoid processes. The width of the occipital condyles is 120 mm and the height of the nuchal crest above the basioccipital is 199 mm. The proximal articulation of the third metacarpal is 56 mm wide.

Ceratotherium Gray, 1867

Ceratotherium simum (Burchell, 1817)

Two species of *Ceratotherium* occur in the Pliocene and Pleistocene assemblages from the Lake Turkana Basin. *Ceratotherium*

praecox Hooijer & Patterson, 1972, was founded on material from Lothagam and Kanapoi to the southwest of Lake Turkana and has been subsequently recognized in strata older than 3 Ma at Langebaanweg in South Africa (Hooijer, 1972), at Hadar in Ethiopia (Guerin, 1985), at Koobi Fora (Harris, 1983:131–132) and in the Tugen Hills sequence (Hill et al., 1985) in Kenya, and Laetoli in Tanzania (Guerin, 1987). *Ceratotherium praecox* was replaced by an extinct subspecies of the extant white rhino—*C. simum germano-africanum*—at about 3 Ma and the latter in turn gave rise to *C. simum simum* at about 2 Ma (Guerin, 1985). In the Omo succession, *C. praecox* is recognized only from the Mursi Formation (Hooijer and Churcher, 1985) while *C. simum* was the common rhino throughout the Shungura sequence.

The upper teeth of specimens of this genus are relatively more hypsodont than those of *Diceros*, are more elongate anteroposteriorly and proportionately less wide, have more obliquely placed lophs, sinuous ectolophs, and have medio-fossettes formed by the union of crotchet and crista. The lower teeth of *Ceratotherium* tend to be taller than those of *Diceros* (the mandibular ramus is correspondingly deeper to accommodate them), and have lophids that, at least in little worn specimens, are more obliquely aligned. The cranium of *Ceratotherium* is more elongate, larger, and the occiput

Rhinocerotid specimen lists and measurements.

Diceros bicornis (Linn., 1758)

Material referred	Specimen	Site	Material referred	Specimen	Site
KNM-WT			KNM-WT		
16727	RM ² , RM ³	LO10	14498	R md frag (RP ₂₋₄ , RM ₃)	LK4
16728	LM ³	LO4	16732	lower teeth (RP ₃₋₄ , RM ₃ , LM ₁)	LO5
16725	LP ³	LO5	16731	occiput	LO3
16726	LP ⁴	LO3	16730	lower teeth frags (RM ₁ , RM ₂)	LO10
16729	RP ² frag	LO10	14501	prox L mc III	NC2

Diceros bicornis dental measurements

	16729	16727	16728	16725	16726		14498	16730	16732
P ² ap ext	33.1					P ₂ ap	27.9		
met	32.7					prot	17.7		
P ³ ap ext				40.5		hyp	21.3		
ap int				40.0		P ₃ ap	40.2		44.9
prot				59.1		prot	24.7		29.3
met				49.6		hyp	30.0		31.7
P ⁴ ap ext					44.4	P ₄ ap	44.2		45.0
ap int					39.8	prot	30.0		25.8
prot					57.2	hyp	34.9		27.5
met					53.0	M ₁ ap			50.2
M ² ap ext		61.1				prot			28.5
ap int		53.4				hyp			31.2
prot		69.9				M ₃ ap	49.8	55.0	53.0
met		56.5				prot	33.4	37.3	31.8
M ³ ap ext		61.5	66.5			hyp	30.0		28.5
ap int		62.8	66.1						
tr		51.1	60.4						

Ceratotherium simum (Burchell, 1817)

Material referred	Specimen	Site	Material referred	Specimen	Site
KNM-WT			KNM-WT		
16734	cranial frags (LP ⁴ -M ³)	LO3	16548	LP ⁴	LO5
17169	md (LP ₂ -M ₃ , RP ₃ -M ₃)	LO3	16709	RM ¹ frag	LO3
16585	R md frags (P ₂ -M ₂)	LO4	16716	RdP ² frag	LO4
14502	R md (P ₃ -M ₃)	LK4	16715	M frags	LO4
16718	R max frag (M ²⁻³)	LO10	16547	LM ₁ frag	LO4
16720	juv maxilla (RdP ³ -M ¹)	LO3	16546	RP frag	LO4
16586	associated teeth (R & L P ⁴ -M ²)	LO5	16549	RP ₂	LO3
16596	L md frags (M ₁₋₃)	LO3	16597	RdP ₂₋₄ frags	LO4
14496	L md frags (dP ₂₋₄)	KL6	17464	RM ¹	NY3
14495	L astragalus	KL6	17503	RM ₃	NC1
14500	prox R int III	KI1	17512	LP ³ frag	KS1
16717	LP ³	LO4	17513	cranial frags	NY3

Rhinocerotid specimen lists and measurements (continued).

<i>Ceratotherium simum</i> dental measurements								
	16586	16718	16720	16734	16717	16548	17464	
dP ³ ap ext			40.2					
ap int			36.8					
prot			46.2					
met			45.9					
dP ⁴ ap ext			45.2					
ap int			43.9					
prot			53.2					
met			51.6					
P ³ ap ext					44.4			
ap int					34.4			
prot					43.5			
met					39.7+			
P ⁴ ap ext	45.9					52.0		
ap int	34.5					43.8		
prot	44.3					52.6		
met	35.1					47.7		
M ¹ ap ext	53.1		58.8				65.5	
ap int	48.8		41.7				55.8	
prot	43.4		44.1				54.1	
met	45.8		35.1				36.6	
M ² ap ext	55.5			54.9				
ap int	61.3			51.7				
prot	50.3	64.1		67.2				
met	56.8	53.2		58.2				
M ³ ap ext		71.1		72.0				
ap int		56.4		57.4				
tr		54.6		47.3				
	14502	16596	17169	16585	14496	16547	16549	16597
dP ₁ ap			20.8					
tr			11.5					
dP ₂ ap					32.9			
prot					17.6			
hyp					19.5			
dP ₃ ap					41.6			
prot					21.8			
hyp					23.3			33.7
dP ₄ ap			45.0		45.3			55.1
prot			32.6		24.5			33.1
hyp			31.7		24.2			35.8
P ₂ ap			34.3				27.1	
prot			21.3				20.0	
hyp			19.4				19.5	
P ₃ ap	37.6		40.0					
prot	28.5		24.6					
hyp	26.5		25.2					
P ₄ ap	48.8		45.3					
prot	28.9		25.7					
hyp	27.4		29.1					
M ₁ ap	41.4	41.5	46.1	41.6		—		
prot	29.4	31.2	27.7	27.8		28.6		
hyp	26.9	—	29.3	28.6		—		
M ₂ ap	49.7	50.3	55.9					
prot	30.2	—	27.0					
hyp	32.0	34.2	26.1					
M ₃ ap	59.8							
prot	28.0+							

Ceratotherium postcranial measurements

Prox MT III	14500	Astragalus	14495
prox ap	46	lat lt	96
prox tr	55	med lt	100
		tib tr	103
		n/c tr	100
		dv	72

slopes backwards and upwards from the occipital condyles rather than being vertically oriented as in *Diceros*.

Twenty-four specimens of *Ceratotherium simum* have been recovered from 10 sites west of Lake Turkana; 16 are from the Lomekwi Member, seven from the Kaitio Member, and one from the Nariokotome Member.

Rhinocerotidae Indeterminate

Several incomplete upper premolars are too fragmentary for identification to genus. These include WT 14497 from LK1, 16509 from LO4, and 14499 from NC1.

It is interesting that the 37 rhino specimens were recovered from only 12 sites. Only two specimens were from sites (KI1, LK1) in the eastern edge of the region and only one specimen was from a site (KS1) which associated faunal evidence suggests was close to a major body of water. Fossil representatives of the two rhino genera thus appear to have shared a similar habitat preference.

Order Artiodactyla

Family Suidae

Notochoerus Broom, 1925

Notochoerus teeth are common from the lower and middle portions of the West Turkana succession. Two species are present—*N. euilus* in the lower portion and *N. scotti* in the middle. They are not always easy to distinguish on the basis of incomplete tooth fragments but *N. euilus* has only four major pairs of pillars in the upper and lower third molars whereas *N. scotti* has five or more. *Notochoerus scotti* teeth also tend to be larger, wider, and taller. It seems probable that *N. scotti* was derived from *N. euilus* but a few teeth with identical morphology to that of *N. euilus*, although rather smaller in size, are documented from the middle part of the Shungura succession (Harris and White, 1979). This morph has not so far been recognized at West Turkana sites.

Notochoerus euilus (Hopwood, 1926)

This was the most common East African suid species during the interval 3–3.5 Ma. Diagnosis, description, and comparative measurements for specimens from various East African localities appear in Harris and White (1979) and a detailed

description of Koobi Fora material in Harris (1983:222–228).

A total of 61 specimens of *N. euilus* have been recovered from six West Turkana sites, three in the upper Kataboi Member, two in the lower Lomekwi Member, and one in the middle Lomekwi Member. The most complete specimen is a partial cranium (WT 16647) from LO4 but the zygomatic arches are incomplete and it is not evident whether these originally bore the knob-like protuberances that characterize male specimens of this species. A second, originally more complete skull from the same locality was observed in 1981 but had been broken up into small pieces, presumably by local people or their domestic animals, before collecting began in 1984. Most of the remaining specimens comprise jaw fragments and isolated (partial) teeth that are comparable in size and morphology to material from other sites of similar age.

Notochoerus scotti (Leakey, 1943)

Originally identified on the basis of specimens from the Omo Shungura Formation, this species is the common notochoere in the Lake Turkana Basin during the interval 2–3 Ma. A synonymy, diagnosis, and comprehensive description of material from known localities is provided in Harris and White (1979) and a detailed description of Koobi Fora specimens in Harris (1983:228–233).

Notochoerus scotti is the common suid in the upper part of the Lomekwi Member (24 specimens), and persists to the Kalochoro (11 specimens) and Kaitio members (two specimens). Five specimens have been recovered from LO9 in the upper part of the lower Lomekwi Member, and single specimens are known also from somewhat older horizons in LO10 and LO5 where they co-occur with the more common *N. euilus*. Three specimens from the upper part of the Lomekwi Member, WT 16253 (LM₃ fragment from LO2), 16278 (LM₃ fragment from LO1), and 16259 (left mandible fragments with P₄–M₃ from KU2), seem definitely to be *N. scotti* rather than *N. euilus* but appear smaller and appreciably more gracile than other representatives of the more progressive species.

Metridiochoerus Hopwood, 1926

This genus, from which the extant warthog is descended, made its initial appearance in Africa about 3 Ma. Four species of *Metridiochoerus* are present in the West Turkana sequence.