vide invaluable ground truth that should permit more specific petrologic interpretation of the x-ray data at a later date.

One specific point of petrologic interpretation can be brought out here. The high Al/Si intensity readings (1.5) over the Descartes site (Fig. 1) are close to those over the farside highlands, which presumably represent premare crust. Although the Apollo 16 surface traverses were on Cayley and Descartes formations (both post-Imbrium basin), there should be abundant fragments of this old, aluminum-rich crustal rock in the regolith samples.

An investigation of the widespread Cayley formation was one of the major objectives of the Apollo 16 mission. It is therefore of interest to note the x-ray intensities (Fig. 1) over the crater Ptolemaeus, whose floor has been mapped by Howard and Masursky (*5*) as Cayley formation. The Al/Si ratios measured over this crater appear to be intermediate between those typical of highlands and maria. If allowance is made for contamination of the crater floor with aluminum-rich material brought from the surrounding area by mass wasting and ballistic transport, the x-ray results seem to be consistent with the interpretation of the Cayley formation, in at least this area, as volcanic rock (probably feldspathic basalt). If confirmed by detailed data analysis, this would provide further support for major volcanism on the moon in the mare basin–mare filling interval, demonstrating the more or less continuous nature of lunar volcanic activity in the first 1.5×10^9 years of the moon's history.

The x-ray experiment of the Apollo 16 mission has provided additional evidence for the existence of a global, differentiated lunar crust. The x-ray results indicate that this premare crust occurs near the Descartes landing site. Further analysis of the data, comparison with samples returned from the Descartes site, albedo-composition correlations, and photointerpretation are in progress.

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Kom Ombo: Preliminary Report on the Fauna of Late Paleolithic Sites in Upper Egypt

Abstract. *A Late Pleistocene fauna comprising 3 fish, 1 reptile, 22 birds, and 14 mammals is identified from sites containing Sebilian, Sebekian, Silsilian, Menchian, and Halfan industries. It is remarkable for its variety, especially of birds, and gives evidence for year-round occupation of these sites.*

The fauna reported here was identified from specimens collected between October 1962 and April 1963 by the Canadian Prehistoric Expedition to Nubia, under the direction of the second author (*1*). The specimens were prepared in either the department of zoology, University of Toronto, or the department of vertebrate paleontology, Royal Ontario Museum, and are deposited in that museum.

The plain of Kom Ombo lies in the valley of the Nile River in Upper Egypt and is centered about the town of Kom Ombo (Fig. 1). The town is located at latitude 24°46′N and longitude 32° 57′E, about 40 km north of Aswan and 600 km south of Cairo. The plain lies mainly on the right or east bank of the Nile River, is about 400 km² in area, and is roughly oval or trapezoid in outline. The surface of the plain is composed of Late Pleistocene sediments deposited by the Nile or by the wadis to the east.

The Kom Ombo archeological sites lie along or are associated with abandoned channels of earlier stages of the Nile River and are all associated or contained within the interbedded sands and silts of the Gebel Silsila Formation (Younger Channel Silts), which have been dated by radiocarbon analysis at between 15,000 and 10,500 B.C., approximately (*2*). Major concentrations of the archeological sites lie near the village of Sebil on the abandoned channel of the same name, about 4 km north of Kom Ombo, and near Gebel Silsila, at the junction of the abandoned Fatira and Manshiya channels at the northern end of the plain, about 2 km east of the village of Fatira. Other sites are near Silsila Station at Khor el-Sil, Fatira Village; near Mata'na Qibli, about 4 km northwest of Kom Ombo; and at Bayara, about 2 km west of Kom Ombo.

The archeological sites include those identified as containing artifacts of

Sebilian, Sebekian, Silsilian, Menchian, and Halfan industries. Only one site (Gebel Silsila III) was stratified and contained a Sebekian occupation level overlying a Silsilian level, with mixed deposits between and overlying them. These industries, which represent some of the final Pleistocene occupations of this part of Egypt, reflect much technological and typological variability, and several at least partially overlap in time. The Halfan seems to be the oldest and the Menchian and later Sebilian the youngest. The Halfan has blades, bladelets, many flakes removed by a miniature version of the Levallois technique, and some grinding stones. The Sebilian is characterized by large and small geometrics made on broad, flat flakes and by various proportions of the Levallois and microburin techniques. The Silsilian is a typical microlithic industry with many bladelets, while the Sebekian emphasizes long, lightly retouched blade tools and the Menchian heavy blades and scrapers. The precise relationships of these industries to each other and to other industries now known in Upper Egypt is still uncertain.

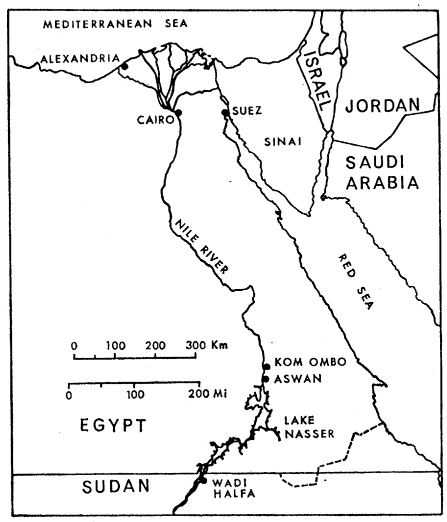
In part this is because, apart from the lithic artifacts, little is known of the aspects of the groups responsible for the remains in most of Egypt and Nubia, with the exception of sites around Kom Ombo. The Kom Ombo area with its unusually well preserved faunal remains helps to illuminate this dimension of the Late Paleolithic cultures of the Nile Valley and thus may aid in understanding the differences between the various industries, at least insofar as the stone tools reflect the subsistence activities of the groups. Since the time interval containing all these sites is less than 5000 years and no faunal succession is evident from the recovered specimens, all the identified taxa are treated as comprising a single assemblage that has been derived from a single fauna (Table 1).

Remains of the catfish were common in all sites and probably represent the most numerous taxon both in numbers and frequency at any site. Bird remains were uncommon except in the Sebekian level of Gebel Silsila III, where their preservation was usually poor, with fragments of long bones scattered throughout the level constituting the best preserved elements. Remains of wild cattle and hartebeest were the most numerous of the mammals, with

Table 1. Vertebrate taxa identified from archeological sites of late Paleolithic age in the plain of Kom Ombo, Upper Egypt. Industries with which the taxa are associated are indicated by Sebil (Sebilian), Sebek (Sebekian), Sil (Silsilian), Men (Menchian), and Half (Halfan). Question marks indicate doubtful identification of the taxon, industry, or association.

Taxon	Associated industry
Pisces	
Clarias anguillaris, Nile catfish, quarmouth	Sebek, Sebil, Sil, Men, Half
Barbus bynni, African barbel	Sebek
Lates niloticus, Nile perch	Sebek
Reptilia	
Trionyx triunguis, Nile soft-shelled turtle	Sebek, Sebil
Aves	
Phalacrocorax carbo, cormorant or shag	Sebek
Ardea cinerea, grey heron	Sebek, Sebil
Platalea leucorodia, spoonbill	Sebek, Sil
Phoenicopterus antiquorum, greater flamingo	Sebek?
?Plectropterus gambensis, spur-winged goose	Sebek?
Anser albifrons, white-fronted goose	Sebek
Anser fabalis, bean goose	Mixed Sebek/Sil at Gebel Silsila III
Branta sp., *?B. bernicla*, brent goose or *B. ruficollis*, red-breasted goose	Sebek
Tadorna ferruginea, ruddy sheld duck	Sebek
Anas platyrhynchos, mallard	Sebek
Anas crecca, teal	Sebek, Sebil
Anas penelope, widgeon	Sebek
Anas acuta, pintail	Sebek, Sebil, Men
Aythya ferina, pochard	Sebek
Mergus merganser, goosander	Sebek
Mergus serrator, red-breasted merganser	Sebek
Mergus albellus, smew	Sebek
Milvus migrans, black kite	Sebek?
Pandion haliaetus, osprey	Mixed Sebek/Sil at Gebel Silsila III
Aquila chrysaëtos, golden eagle	Half
Grus grus, crane	Sebil?
Numenius ?arquatus, curlew	Sebek
Mammalia	
Homo sapiens, man	Sil (indirect evidence at all other sites)
Canis sp., *?C. lupaster*, Egyptian wolf-jackal or *C. familiaris*, domestic dog	Sebil
Hyaena hyaena, striped hyaena	Sebil?
Crocuta crocuta, spotted hyaena	Sebil? (*4*)
Lepus capensis, Cape hare	Mixed Sebil/Sebek/Sil, ? Sebil
Nesokia indica, Egyptian bandicoot or pest rat	Half
Equus asinus cf. *africanus*, Nubian wild ass	Sebek, Sebil, Sil
Hippopotamus amphibius, hippopotamus	Sebek, Sebil, Sil, Men
Bos primigenius, wild cattle	Sebek, Sebil, Sil, Men, Half
?Homoioceras vignardi, extinct long-horned African buffalo	Unassociated
Alcelaphus buselaphus, bubal hartebeest	Sebek, Sebil, Sil, Men, Half
Gazella dorcas, Dorcas gazelle	Sebek, Sebil, Sil, Men, Half?
?Gazella leptoceros, rhim or white gazelle	Sebek?
Ammotragus lervia, Barbary sheep	Unassociated

Fig. 1. Map of northeastern Africa and adjacent Asia Minor showing the location of Kom Ombo and other localities mentioned.



those of Dorcas gazelle, hippopotamus, and Nubian ass next most numerous in descending order of frequency. All other taxa were sparsely or uniquely represented.

Vertebrate remains have previously been reported from the Kom Ombo Plain by Vignard (*3*), Gaillard (*4*), Sandford (*5*), Reed (*6*), Reed and Turnbull (*7*), Oakley (*8*), and Smith (*9*). In summary these authors recorded catfish, man, spotted hyaena (*4*), Nubian ass, hippopotamus, long-horned and short-horned cattle, long-horned and short-horned African buffalo, bubal hartebeest, and Dorcas gazelle. The record of horse [*Equus caballus* (*4*)] may be discredited (*7*) and that of short-horned cattle (*Bos brachyceros*) or Cape buffalo (*Syncerus caffer*) is dubious.

The mammalian elements derive from both adult and immature individuals when there are sufficiently large samples for both age categories to be represented. Since gazelle in Arabia drop their young in either January or late July to August and oryx bear their calves between May and December (*10*), this suggests that hartebeest may have behaved similarly at the same latitude. Thus, it appears that the Kom Ombo Plain was occupied at least during those months of the year or shortly thereafter. The abundance of water birds present in Egypt only during the northern winter indicates that, at least at Gebel Silsila III during Sebekian times and probably at other sites also, the plain was occupied by man during the winter months of January to March. It is tentatively concluded, therefore, that the Kom Ombo Plain was occupied throughout most of the year by at least part of the population during Late Pleistocene times. The presence of catfish, some of large size, and of hippopotamus and wild cattle suggests that these may have been hunted when the river level was low and the animals drawn to the available forage and restricted water holes.

The general faunal aspect is that of the savanna or orchard bushveld biome with grazing plains or grassland species in contact with species more intimately dependent on riverine woodland and permanent water. Dorcas gazelle and hartebeest are possible indicators of dry savanna conditions, at least at some period of the year, while wild cattle and hippopotamus indicate the presence of permanent bodies of water.

The presence of the Egyptian bandicoot or pest rat indicates a wetter climatic regime than obtains in the region today (*11*) and supports its identification by Robinson (*12*) from Dabarosa West near Wadi Halfa. The avifauna from Gebel Silsila III also suggests a wetter regime, at least during the winter, with large, shallow meanders and side channels in which catfish would live. The restriction of abundant remains of avifauna to the upper levels of Gebel Silsila III is puzzling, and has been attributed to differential preservation at other sites along the Nile River, presumably where conditions did not allow the smaller elements of birds or rodents to be preserved. Alternatively, there may have been some difference in the mode of life of the Sebekian inhabitants that allowed them to use this source of protein more extensively than did those with other industries (*13*).

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Birch's Law: Why Is It So Good?

Abstract. *Birch's law arises in the physics of solids as a linear approximation, in a certain range of density, of a power law. For a change of chemical composition within the same crystal structure, the velocity-density relation is constant with a slope of nearly —0.5 in the first-order approximation.*

Birch's law is a velocity-density relation among oxides and silicates, important in the study of the elasticity and constitution of the interiors of the earth and other planets (*1*). The law is based on experimental observations. It states that the velocity V of elastic waves in oxides and silicates is mainly a function of density ρ and mean atomic weight $\overline{m}$:

$$V = a(\overline{m}) + b\rho \qquad (1)$$

where a and b are constants, frequently referred to as Birch's constants, and the mean atomic weight is defined as the product of the molecular weights divided by the number of atoms in 1 mole of the substance. Although Birch's law is used in most geophysical theories and models of the elasticity of the earth, the validity of Eq. 1 over the entire range of density distributions in the earth's interior has not been analyzed. Furthermore, the physics behind Birch's law is not yet generally understood (*2*). In this report I examine how Birch's law arises in the physics of solids.