THE UNIVERSITY OF CHICAGO ORIENTAL INSTITUTE PUBLICATIONS

Edited by

JAMES HENRY BREASTED

PREHISTORIC SURVEY OF EGYPT AND WESTERN ASIA—VOLUME I

PALEOLITHIC MAN
AND
THE NILE-FAIYUM DIVIDE

THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

THE BAKER & TAYLOR COMPANY
NEW YORK

THE MACMILLAN COMPANY OF CANADA, LIMITED
TORONTO

THE CAMBRIDGE UNIVERSITY PRESS
LONDON

THE MARUZEN-KABUSHIKI-KAISHA
TOKYO, OSAKA, KYOTO, FUKUOKA, SENDAI

THE COMMERCIAL PRESS, LIMITED
SHANGHAI

THE UNIVERSITY OF CHICAGO
ORIENTAL INSTITUTE PUBLICATIONS
VOLUME X

PREHISTORIC SURVEY OF EGYPT AND WESTERN ASIA—VOLUME I

PALEOLITHIC MAN AND THE NILE-FAIYUM DIVIDE

A STUDY OF THE REGION DURING PLIOCENE AND PLEISTOCENE TIMES

BY

K. S. SANDFORD *and* W. J. ARKELL

THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS

 PUBLISHED DECEMBER 1929

COMPOSED AND PRINTED BY THE UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS, U.S.A.

FOREWORD

This volume contains much of importance for the geologists; but in so far as its contents are addressed to them no introductory comments are necessary, nor does the present editor possess the competence to offer any. On the other hand, the Prehistoric Survey, of whose work this volume forms the first detailed report, was instituted primarily for the archaeologists and students of prehistory; and for them a few words of explanation are necessary.

The requirements of economic geology have confined very largely to the desert plateau and the Red Sea littoral the researches of the Geological Survey maintained by the Egyptian government. Hence important problems concerning the origin of the Nile Valley itself, especially between the First Cataract and the Mediterranean, have never been solved. Even so fundamental a question as whether this Egyptian portion of the Nile Valley was of rift origin or due to erosion has been settled only recently in favor of erosion. Now the archaeologist who undertakes the study of man's earliest appearance in Northeastern Africa and his prehistoric progress there finds himself involved in very complicated problems of Nile Valley geology. Lacking an adequate knowledge of the geological background, the archaeologist finds that his efforts to deal with the Paleolithic data lead him very easily astray. Indeed, we are confronted today by more than one widely used book marred by misleading geological observations from which the archaeologist has drawn ungrounded conclusions. In prehistoric archaeology, unhappily, the observations made in Egypt have so often been *surface* observations that our museums are quite commonly equipped with collections of flint artifacts found on the surface and hence of little or no value.

Nearly fifty years ago Pitt-Rivers made the fundamentally important discovery of Paleolithic implements imbedded in the lowest river terrace on the west side of the Nile at Luxor. He did not follow up his discovery, and for many years it remained an isolated observation little heeded by other investigators. At length similar observations, more carefully recorded, were made by Schweinfurth in the same region. After a long pause the persistent investigations of Père Bovier-Lapierre, librarian of the Collège de la Sainte Famille in Cairo, have resulted in important discoveries of Paleolithic implements buried in exposed strata in the region about Cairo. His *surface* observations also have been of great importance, including as they do a series of rock structures which seem to be dolmens, hitherto unknown in Northeastern Africa, and a Neolithic station south of Cairo. Reverting, however, to stratigraphically dated artifacts, with which this discussion is primarily concerned, the only excavations in search of such evidence, so far as I know, have been those of Vignard in the Kom Ombo plain.[1]

It is a noteworthy fact that in the effort to collect and study the evidence of prehistoric human occupation of the Nile Valley, no systematic and comprehensive survey of Egypt has ever been made. The same is true of Western Asia, especially the ancient lands of Babylonia, Assyria, Palestine, Syria, and Asia Minor. Lack of such a survey has left a serious gap in our knowledge of the earliest human development in the ancient Near East, where civilization first arose. In undertaking such a survey on comprehensive lines, it was obvious from the first that the detailed problems of geology involved would far exceed the competence of the prehistoric archaeologist. The Oriental Institute therefore appointed a staff of fully accredited professional geologists who at the same time possessed sufficient competence in prehistoric archaeology to deal with the archaeological evidence which they were to collect and study.

In the program which this expedition was expected to carry out, there were two fundamental items: *first,* to search the geological formations for imbedded human handiwork or other traces which would date in geological terms the earliest human occupation of the Nile Valley, and to follow such traces as far down toward the historic epoch as possible; and *second,* to investigate the geological background of prehistoric man in Northeastern Africa, so that all natural formations containing human artifacts might be geologically dated and their genetic place in the geological sequence determined within as narrow limits as possible.

A preliminary statement of the progress of the work during the first two seasons has already been issued by the authors in the "Oriental Institute Communications," No. 3, in a form intended chiefly for the popular reader. It was not intended to publish a detailed presentation of the results of this Survey until its study of the Nile Valley as a whole was further advanced; but the fundamentally important observations which the authors have made in and around the Faiyum, not only dating the origin of that great depression in the western plateau, but also making possible for the first time a far-reaching synthesis of the important stages of human development in the lower Nile Valley, form a coherent body of results which ought to be made available to science without further delay.

Among the most important observations recorded in this volume is the

[1] Cf. p. 52.

discovery of a great stretch of gravel which formed the bottom of an enormous Nile following the close of the Tertiary age. The authors have followed this old Nile bottom for some fifty miles and have found in it Lower Paleolithic implements of Chellean and Acheulean types. These implements disclose the advent of man in the Nile Valley at a definite stage in its Plio-Pleistocene and Pleistocene excavation. If these implements are contemporary with the Chellean and Acheulean of Western Europe, they furnish valuable confirmation of the general geological position of the Lower Paleolithic in European prehistory, as recently assigned to the *first* interglacial, warm interval (Günz-Mindel), rather than to the *third* interglacial period (Riss-Würm) as long supposed by the French school. If dated to Plio-Pleistocene times in Egypt, these finds of Sandford and Arkell perhaps raise the question whether the cruder technique of the Lower Paleolithic stage passed so slowly to Europe over the Sicilian land-bridge that it arrived in Western Europe at a time later than its emergence in Northeastern Africa. It will be wise to await the further results of the present Survey before reaching any conclusions on these important questions; but already it seems evident that we must give further attention to the presence of the Sicilian land-bridge which connected Europe and Africa until far down in the Neolithic age. The present writer has already called attention to the migration of domestic animals westward from Egypt along the northern coast of Africa toward this land-bridge, as shown by the earliest inscribed documents as yet found on the Nile.[1] The results of this prehistoric Mediterranean connection between North Africa and Southern Europe are evident in the grain, flax, and live stock of the Swiss Lake-Dwellers.

In this connection the authors have furnished us with an exceedingly valuable datum in their demonstration that the desiccation of the Sahara Plateau began not earlier than the Middle Paleolithic. During the whole of the Lower Paleolithic, therefore, the North African plateau enjoyed plentiful rainfall and the coastal region will probably have been covered with vegetation. Our inscriptions and reliefs regarding the Libyans indicate that such was the case in the region west of the Delta even in the fourth millennium B.C., that is, long after the desiccation was presumably complete. A coastal belt enjoying some fertility would have made connection between Egypt and the West much easier than at present. It was not until Late Paleolithic times that the desiccation began; and its advance will have been gradual, with some periods of reversion to pluvial conditions. Without doubt the advent of complete desiccation had a profound influence on the life of the former hunters of Northeastern Africa, who had taken refuge in the Nile Valley. As hunting became more difficult,

[1] See *Scientific Monthly*, Nov., 1919, p. 426.

owing to the desiccation, food conditions favored the development and advance of agricultural life.

The beginnings of the agricultural life, however, and the early stages of the age called Neolithic in Europe are buried deeply under accumulations of black alluvium brought down by the Nile. Lacking this inaccessible evidence, the prehistoric archaeologist has hitherto been unable to trace the transition from the outgoing Paleolithic in the Nile Valley to the incoming Neolithic, with pottery, agriculture, and cattle-breeding. All archaeologists will therefore be grateful to the authors for their invaluable discovery of a body of evidence which for the first time bridges this gap. In tracing a Nile terrace which contained Middle Paleolithic (Mousterian) artifacts, the authors were able to follow this terrace out of the Nile gorge, through the gap connecting the latter with the great Faiyum depression, and thus into the Faiyum itself. Here the Neolithic stage has *not* been covered by Nile alluvium; and below the Middle Paleolithic terrace the authors discovered a surprising succession of lake terraces, marking the successively lower levels of the shore of the shrinking Faiyum lake from Mousterian times down to the Neolithic. For the first time, therefore, we are now possessed of evidence which carries human development in the Nile Valley, and indeed in Northeastern Africa, from the earliest stages of the Paleolithic in Plio-Pleistocene times to the Neolithic of probably not more than eight or ten thousand years ago.

To be sure, some gaps in the development remain to be filled; but the success of the authors in these earliest stages of their far-reaching and difficult researches furnishes substantial ground for the expectation that much can still be found to fill these gaps. In any case, my own anticipations of what such a survey might fairly be expected to accomplish, in restoring to us the lost stages of early human advance in the Nile Valley, have been very gratifyingly surpassed; and I take this occasion to express to the authors my heartfelt appreciation of the splendid results they have achieved. It will no longer be necessary, as heretofore, to employ the story of Stone Age *Europe* as an introduction to the early history of Egypt and the Near East. We possess already in this volume a skeleton of the Stone Age stages of Northeast African development, and another five years' progress of these prehistoric researches will without doubt contribute much to put flesh on the skeleton.

JAMES HENRY BREASTED

THE ORIENTAL INSTITUTE
UNIVERSITY OF CHICAGO
September 1, 1929

TABLE OF CONTENTS

PAGE

List of Illustrations . . . xiii

I. Introduction . . . 1

II. Outline of the Geological History of the Region before the Pliocene Period . . . 5

III. The Pliocene Period . . . 11

The Fossiliferous Marine Pliocene and Its Relation to the Gravels . . . 12

The High-Level Gravels . . . 16

The High-Level Gravels on the Eastern Nile-Faiyum Divide . . . 16

The High-Level Gravels on the Northeast of the Faiyum . . . 19

The Water-Level in the Pliocene Gulf . . . 22

IV. The Plio-Pleistocene Terraces . . . 24

V. The Pleistocene Period . . . 28

Introduction: The Lower Paleolithic Stage . . . 28

The Deposits of the Lower Paleolithic Stage[1] . . . 32

The Middle Paleolithic Stage . . . 34

The Deposits of the Mousterian Stage . . . 37

Notes on the Mousterian Implements . . . 45

The Late Paleolithic Stage . . . 52

The Deposits of the Late Paleolithic Stage . . . 54

Younger Lakes . . . 57

Notes on the Late Paleolithic Implements . . . 61

The Transition to Neolithic Times, and Conclusion . . . 66

VI. Summary . . . 70

Appendix . . . 73

Index . . . 75

[1] The deposits of each stage are described regionally, so far as possible, under subheadings in the following order: (a) Nile Valley adjacent to the Faiyum, (b) The Hawara Channel, (c) Within the Faiyum.

LIST OF ILLUSTRATIONS

PLATES

PLATE

I. Pliocene Bowlder Conglomerate
   A. In the Side of the Rus Channel
   B. On the East Side of Gebel Naᶜallun

II. *A*. Cross-Section of the Pliocene-filled Meidum Pyramid Valley (P. 21), Forming the Cliffs Overlooking the Faiyum
   B. Topography Cut in Pliocene Gravels 100 Feet Thick. Gebel Naᶜallun

III. Plio-Pleistocene Terraces and Sanded-up Pliocene Country Southwest of the Dahshur Pyramids (Seen in *A*)

IV. *A*. The Gravels of the Paleolithic Channel Dissected by the Bahr Yusef at Sedment Monastery
   B. Surface of the Mousterian (112-Ft.) Beach near the Hawara Pyramid, Showing Shells of *Corbicula artini* and *C. innesi* (cf. Plate XI, *B*)

V. *A*. The Mousterian Beach Banked on Eocene Limestones, at the Implement Site under Gebel er-Rus
   B. Leveling the Marginal Gravels of the Mousterian (112-Ft.) Lake, near Ḳalamsha

VI. *A*. The Mousterian Beach Running round the Foot of Gebel er-Rus, at the Top of Which the Pliocene Conglomerate Simulates a Terrace
   B. The Sebilian (92-Ft.) Lake Deposits (Forming a Fanlike Feature) South of Gebel er-Rus, as Seen from the Summit

VII. The Sebilian (92-Ft.) Beach
   A. The Storm Beach Circling the Bay North of Gebel er-Rus (Seen in Distance)
   B. At the Prolific Implement Site at Philadelphia, Where the Deposits Have Been Cut Back to Form a Low Cliff by the Water of the 74-Foot Lake

VIII. Part of the Series of Ten Small Beaches at Shaḳluf Bridge (See Text Figs. 20 and 3). The Cliff Behind Consists of Fossiliferous Pliocene Strata

IX. The Storm Beach of the 74-Foot Lake, North of the Ruins of Philadelphia

X. Rain and Wind Erosion in the Faiyum
   A. A Rainstorm from the Southwest Crossing the Desert North of the Lake, as Seen from the Temple of Ḳasr es-Sagha
   B. Hard Eocene Limestone Fluted by Wind-borne Sand, above Ḳasr es-Sagha

XI. The Birket Ḳarun, the Modern Relic of the Faiyum Lake
   A. A Still Day on the North (Desert) Shore at Dimei, Showing Fringing Dunes with Tamarisk
   B. A Rough Day on the South (Cultivated) Shore; Notice the Dwindled "Storm Beach"

MAP

The Eastern Faiyum Desert . . . . *at end*

TEXT FIGURES

FIGURE		PAGE
1.	Diagrammatic Section across the Faiyum, to Show General Structure	6
2.	Showing Formation of Slips in the Nile Valley during the First Cutting-down in pre-Middle Pliocene Times	12
3.	Section in the Pliocene at Shaḳluf Bridge, the Western Edge of the Desert Divide between Nile Valley and Faiyum	13
4.	Generalized Section along the Cliffs from Gebel Naᶜallun (North) to the Region South of Ḳalamsha (South), Showing the Pliocene Deposits on the Faiyum Side of the Desert Divide	14
5.	Diagram Illustrating the Pliocene River-System Draining into the Nile Valley Gulf	18
6.	Diagrammatic Sections across Pliocene Valleys in Upper Egypt (Luxor) and the Faiyum Region	19
7.	Diagrammatic Section through the Upper Reach of the Pliocene Dahshur Pyramids Valley from Birket Ḳarun to Ilwet Hialla (the Oligocene Escarpment)	20
8.	Chellean *Boucher* from Lower Paleolithic Gravels near Kom Tima. Natural Size	30
9.	Acheulean *Boucher* from Lower Paleolithic Gravels near Kom Tima. Natural Size	31
10.	Longitudinal Section along the Hawara Channel, Showing the Relation of the Terraces and Beaches	39
11.	Section in Mousterian Beach Deposits near Ḳasr Basil (Tutun)	43
12.	Mousterian Core from the 112-Foot Beach near Gebel er-Rus. Natural Size	46
13.	Mousterian Core from the 112-Foot Beach near Gebel er-Rus. Natural Size	47
14.	Mousterian Core from the 112-Foot Beach near Gebel er-Rus. Natural Size	47
15.	Mousterian Core from Gravels of the 25-Foot Nile Terrace at Hammam Monastery, near the Lahun Pyramid	49
16.	Mousterian Core from the 112-Foot Beach near Ḳasr Basil (Tutun). Natural Size	49
17.	Mousterian Core from the Beach of the 112-Foot Lake, Ḳasr Basil (Tutun). Natural Size	50
18.	Mousterian Flakes from Beaches and River Gravels: No. 1 from 112-Foot Beach, Ḳasr Basil (Tutun); No. 2 from Dimishḳin; No. 3 from 25-Foot Nile Terrace, Kom Tima. Natural Size	51
19.	Retouched Mousterian Flakes from the 112-Foot Beach near Ḳasr Basil (1) and Gebel er-Rus (2). Natural Size	53
20.	Series of Beaches Showing Falling Lake-Level, Shaḳluf Bridge, between Ḳasr Basil and Ḳalamsha	58

FIGURE PAGE

21. Section in Dry Canal near Ezbet George 60

22. Late Paleolithic (Sebilian) Double-ended Cores from the 92-Foot Beach near Philadelphia. Natural Size 62

23. Late Paleolithic (Sebilian) Flakes from the 92-Foot Beach: Nos. 1–3 Found near Philadelphia; Nos. 4–7 Found near Dimishķin. Natural Size 64

24. Core of Late Paleolithic (Sebilian) Age, from the 92-Foot Beach near Philadelphia. Natural Size 64

25. Nos. 1–3, the Small Flakes Deposited at the 54-Foot Level by the 74-Foot Lake at Ezbet George as Shown in Fig. 21; Nos. 4–5 from Ancient Surface Wash Resting upon 112-Foot Lake Deposits at Ķasr Basil (Tutun) as Shown in Fig. 11. Natural Size 65

I

INTRODUCTION

The appearance of this work in its present form is due to a series of unforeseen events. It was our original intention to embody our observations on the Faiyum region in a more comprehensive survey of the Nile Valley. The season 1926–27 had been devoted to Upper Egypt. According to plan, we should have worked northward in the following season, 1927–28, probably not reaching the Faiyum until a year later.

At the end of the 1926–27 season a member of the University of Michigan Expedition at Kom Aushim, on the north side of the Faiyum, reported archaeological discoveries of great importance in the vicinity. At that time, however, there was no competent archaeologist ready to investigate them and preserve them from the hands of the spoiler. Almost at the same time came the sad news of the death of Professor Kelsey, director of the Michigan enterprise. Professor Breasted was thereupon invited to undertake the task of investigation with the resources of the Oriental Institute. An agreement was reached between the two universities and the Service des Antiquités in Cairo; and in December, 1927, we were diverted into the Faiyum in support of, and in partial co-operation with, an archaeologist specially appointed.

The archaeological work, which does not concern us here, occupied about a month, after which we were again free to resume our survey. Finding ourselves in the Faiyum, which ultimately we should have to investigate in relation to the Nile, we decided to start upon the task forthwith. Here seemed to lie the possibility of solving some of the mysteries which had occupied us in the Nile Valley. Paleolithic[1] and later implements lay scattered over the surface; vast sheets of Nile gravel spread high over the desert on the outer side of the divide separating the Nile Valley from the Faiyum; while on the inside a series of storm beaches reminiscent of the seacoast skirted the desert. Lastly, there was on all sides an unrivaled development of Pliocene rocks, ranging from coarse conglomerates through hundreds of feet of gravel to fossiliferous marine sediments, little of it as yet even mapped.

The traveler who enters the great depression of the Faiyum for the first time

[1] The English spellings originally used by the authors (e.g., Palaeolithic) have, with their kind permission, been replaced by the American spellings preferred by the Oriental Institute throughout its publications.—EDITOR.

should do so by the desert road from Cairo, or by the shorter desert route, which is longer in total distance, from the Nile Valley at Gerzeh, reaching the depression at the Greco-Roman ruins of Philadelphia. By these routes he climbs steadily up from the Nile Valley across a desert waste of gravel and sand which, from his experience at all other points along the Nile Valley, he expects to lead him up to the high plateau of the Libyan Desert. But here he no sooner reaches the summit of the ascent than he sees stretching before him, not the high arid surface of the Libyan Plateau, but a vast green hollow scooped out of the desert. He sees a green thread passing transversely through the desert divide, with the pyramids of Lahun and Hawara at either end, and through this narrow connection a canalized branch of the Nile flowing into the basin to irrigate the green fields and palm trees of the Faiyum. In the far distance, in the deepest part of the basin, he discerns the shining surface of a lake, the Birket Ḳarun, lying some 147 feet below sea-level, with the high cliffs of the Libyan Plateau towering beyond.

About this depression Egyptologists have fought some of their fiercest battles. They have raged over the subject of the famous Lake Moeris, which was stated by Herodotus to fill the depression at the time of his visit under the Persian régime in the fifth century B.C. Some score of papers and treatises have been written to prove at what level the lake stood during the time of the Ptolemies or the Twelfth Dynasty pharaohs, which king it was who drained the lake and turned the bottom into cultivated fields, or who cleaned out and canalized the natural connection with the Nile and built the great dam across the entrance. But fascinating though these matters are to the archaeologist, they bring us no nearer a solution of the fundamental problems presented by the basin, the archaeologists having evaded the questions as to when and by what agency this extraordinary depression came into being. While we are still faced with the unanswered problems presented by the existence of a cavity carved out of the face of the desert to a depth of 150 feet below sea-level and surrounded by steep cliffs up to and over 1,000 feet in height allowing no visible outlet, it seems mere quibbling to occupy ourselves with the minute rising and falling of the lake during historic times.

From reading such authorities as Sir R. Hanbury Brown, *The Fayûm and Lake Mœris*,[1] we gain the impression that the channel at Hawara connecting the Faiyum with the Nile is only a shallow one, it being traditional that a rock ledge exists close beneath the alluvium. If this were so, the Faiyum could never have been excavated by water, as there is no other outlet providing an escape for such water lower than about 200 feet above the surface of the Birket

[1] London: Edward Stanford, 1892.

Ḳarun. To meet this difficulty it has been suggested that the basin was excavated by wind action, attention being drawn to the potency of wind erosion in the desert at the present day. Mr. H. J. L. Beadnell, however, in his authoritative work on *The Topography and Geology of the Fayum Province of Egypt*[1] expressed his opinion that the basin was already in existence as such in Pliocene times, which carries us back long anterior to the beginning of desert conditions and so rules out the possibility of desert wind erosion. That Beadnell's conclusion was, as a matter of fact, based on incomplete evidence, the true interpretation of which has only been arrived at after study beyond the boundaries of his map, we hope to show later. His memoir finally disproved the theory that the depression was due to faulting, as certain foreign geologists had suggested.

In the latest work to appear in print, the painstaking treatise by Miss G. Caton-Thompson and Miss E. W. Gardner, "Recent Work on the Problem of Lake Moeris,"[2] the long and important history of the basin before Neolithic times is dismissed in a few lines, although the Neolithic and later stages are dealt with in minute detail. All the earlier lake deposits are regarded as the traces of a falling sheet of water, considered vaguely as of Middle Paleolithic age, apparently from the occurrence of Mousterian implements on the surface to a certain level and "judging by the associated implements."

It was such problems, then, which may be considered to end where the work of Miss Caton-Thompson and Miss Gardner begins, that we set ourselves to solve during the early months of 1928. The first essential was to map geologically the desert divide separating the Faiyum from the Nile Valley. This map we now present on a reduced scale. The making of the map insured a thorough acquaintance with every part of the area, so that few fossil localities or implement sites are likely to have escaped us. Large collections of fossils and implements were made, and the series of beaches and terraces were mapped and leveled over a distance of some fifty miles, on both sides of the divide.

The most striking results of this detailed work were:

1. The determination of the nature, distribution, and probable former extent of the Pliocene deposits.
2. The discovery of a series of high Plio-Pleistocene terraces of the Nile up to 470 feet above river-level. Since they antedate the formation of the Faiyum basin, that event was thereby relegated to Pleistocene times.
3. The discovery in the adjoining part of the Nile Valley of a high gravel terrace containing mixed Lower Paleolithic implements.
4. The establishment of a Mousterian terrace in the Nile Valley and a corresponding beach

[1] Cairo: National Printing Dept., 1905.

[2] In the *Geographical Journal*, LXXIII (1929), 20–60.

system within the Faiyum, with abundant implements and fossils *in situ* in both, and the connection of these through the Hawara Channel, with a fall toward the Faiyum.

5. The establishment of a similar but lower beach system with Late Paleolithic implements *in situ* within the Faiyum, with an increased fall through the Hawara Channel toward the Faiyum.
6. The joining on of these two lake systems to the highest lake dealt with by Miss Gardner, with the consequent strong supposition that her earliest lake (74-foot) is Late Paleolithic in age.
7. The relegation of the cutting of the deepest part of the depression to the period between Miss Gardner's 74-foot and 57-foot (Neolithic) lakes, for which interval she herself has provided abundant evidence of erosion.
8. The correlation of this degradation with the period of the cutting of the deep channel in the Nile Valley, now filled up, and the consequent inference that the Faiyum lake and the Nile were still connected via the Hawara Channel.

These conclusions were first published in the form of a brief summary as a letter to *Nature*.[1] They will be developed and the evidence presented in the following pages.

Before proceeding, we are anxious to express our thanks for many kindnesses shown us in Egypt. We are indebted in the first place to the senior officials of the Survey Department of Egypt and the Service des Antiquités. The field director of the University of Michigan camp at Kom Aushim, Mr. Enoch E. Peterson, gave us invaluable assistance and much-appreciated hospitality, which made our work both easier and more enjoyable while we were in the vicinity. To Dr. and Mrs. Askren of Medinet el-Faiyum we owe such countless kind offices and hospitality that our thanks are inadequate.

In England, Major Connolly has kindly helped at the British Museum with the identification of some of the fresh-water mollusca.

[1] April 28, 1928, p. 670.

II

OUTLINE OF THE GEOLOGICAL HISTORY OF THE REGION BEFORE THE PLIOCENE PERIOD

The Nile Valley and the Faiyum are excavated in a plateau of Lower Tertiary rocks, a raised sea bed, which forms the greater part of the northeastern corner of Africa. In Egypt the rim of this plateau crosses the Nile Valley south of Luxor, where the Cretaceous shales and Lower Eocene limestones are seen to rest unconformably on the Nubian sandstone. From here northward to the latitude of Assiut the Nile runs through a gorge cut in the Lower Eocene limestones, which (near Assiut) dip below the surface and are succeeded by the Middle Eocene, a more varied series of sands and clays, sandstones, and subordinate limestones. From Assiut to the Delta, before which the Middle Eocene in turn dips below the younger rocks, the Nile Valley is wider than in Upper Egypt, and its sides less precipitous, owing to the softer condition of the rocks. It is in this northern, more varied plateau of Middle Eocene sediments that the Faiyum depression is situated.

In the Middle Eocene period, when these deposits were being laid down, the major features of the geography of the Near East were not yet initiated. The primitive Mediterranean (known to geologists as the Tethys) spread far over North Africa, Sinai, and Arabia, and occupied much of what is now Southern Europe, while the Alps and the contemporary mountain chains had not yet been formed.

In Egypt the sediments of the Middle Eocene sea probably spread many miles south of their present boundary near Assiut, having since been removed by erosion. Their area, however, was considerably smaller than that covered by the Lower Eocene limestones; and much of the subsequent history of this region is one of a contracting Tethys, continually retreating northward to the bounds of the present Mediterranean. The northerly retreat of the coast line was due to the gradual elevation of the North African plateau. As the land rose, the sea grew shallower and the sediments laid down on its bottom became coarser and more varied, showing to an increasing extent the influence of neighboring land.

The Middle Eocene of the Faiyum (see *ME 1–3* on folding map) has been divided by Beadnell[1] into (1) the Wadi Rayan series, (2) the Ravine beds, and (3) the Birket Ḳarun series. The Wadi Rayan series forms the southern rim

[1] *Op. cit.*, pp. 35 ff.

of the depression, and the Ravine beds form the eastern rim and the floor. The Ravine beds appear below the alluvium in the deep water-channels or ravines connecting the Nile with the Birket Ḳarun. They consist of white clays, marls, limestones, and mudstones, some of the bands highly charged with gypsum.

The Birket Ḳarun series above them consists of yellow sands with large melon-like concretions, followed by yellow sandy limestones and sands crowded with the marine organisms *Nummulites* and *Operculina.* This series forms the northwestern rim of the depression, where its melons are a conspicuous feature of the northern shore of the Birket Ḳarun. The northwesterly dip of the series is such that the concretionary or melon beds on the lake shore, 150 feet below sea-level, rise to form cappings to the highest hills on the eastern divide between the Faiyum and the Nile Valley, 300 feet above sea-level. The *slope of the floor*

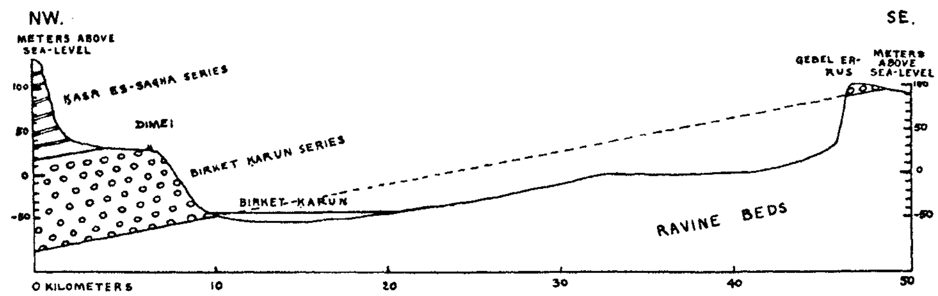


FIG. 1.—DIAGRAMMATIC SECTION ACROSS THE FAIYUM, TO SHOW GENERAL STRUCTURE

of the Faiyum depression downward toward the deepest part in the northwest, therefore, *approximates roughly to the natural dip of the rocks* (see Fig. 1).

Bounding the deepest part of the depression in the northwest is a range of lofty cliffs formed by the Upper Eocene series (*UE* on map), 150 meters thick.[1] Scattered bowlders and slipped masses of this series, too large to have been transported, show that it once covered the whole of the Faiyum as far south at least as Sedment. Unless it thinned very rapidly toward the south, it would have risen there to a height of 300 meters above sea-level, double the height of the present highest points.

The Upper Eocene strata are essentially littoral, denoting a shallower sea than that which covered the Faiyum during the Middle Eocene period. The fine sections provided by the cliffs of Ḳasr es-Sagha, above the waters of Birket Ḳarun, show an irregular alternation of two types of sediment. The greater part of the series is composed of unfossiliferous current-bedded sands and sandy shales. At intervals of from ten to thirty or more feet this is interrupted by thin horizontal limestone bands largely composed of marine shells

[1] The Ḳasr es-Sagha series; originally included by Beadnell in the Middle Eocene.

and sometimes containing rolled fragments of coral. Toward the eastern border of the Faiyum the shell bands approach closer together and the series diminishes to two-thirds of its thickness on the west. This thinning is due to the dwindling of the beds between the fossil bands; the beds become more argillaceous and sometimes themselves contain marine fossils.

The type of current-bedded deposit forming the greater part of the cliffs at Ḳasr es-Sagha, and known geologically as "Wealden," is indicative of the proximity of a river mouth. Moreover, bones of land vertebrates are present, requiring the agency of a river to transport them into the sea and mingle them with marine shells. The Upper Eocene thus contains the first evidence of a river flowing into the Mediterranean consequent on the uplift of the Lower Eocene sea bed of North Africa to form a land surface. All the succeeding phases of Egyptian geology are inseparably connected with the history of such a river, of which a much-diminished representative is recognizable in the present Nile.

The Upper Eocene period came to an end with a further and comparatively sudden rise of the land, bringing the coast line farther north until it probably reached the latitude of the Faiyum. At first this region became an estuary, in which red and mottled clays were formed and into which vast quantities of quartz sands were poured (*O* on map), together with the bones of numerous land animals. The study of these bones by Andrews, Beadnell, Forster Cooper, and others has made known the richest and most interesting mammalian land fauna of Tertiary age in Africa, and the "Faiyum Fauna" is spoken of by geologists the world over.

As the Lower Oligocene estuary became filled up and the northerly advance of the shore line probably continued, a vast delta of typical river gravels (*O* on map) was spread out over what is now the northern Libyan Desert. Standing on one of the high hills formed of them between the Faiyum and Cairo, one finds it difficult to believe that they were brought down in so remote a period as the Oligocene; but their composition proclaims their antiquity. The Pleistocene gravels of the Nile contain igneous and metamorphic rocks brought down from the Red Sea Hills. The gravel sheets of the high desert, however, contain only pebbles of flint and chert, quartz, quartzite, and jasper, derived from the erosion of the Lower Eocene limestones and Nubian sandstone of the North African plateau, then newly elevated into a land surface. The absence of the other rocks indicates that at that time the core of the Red Sea Hills either had not been uncovered or was excluded by some still unbroken barrier from the catchment area of the Nile.

Among the gravels, trunks of forest trees were floated down in large quantities. Having become silicified, they are almost indestructible and still litter the surface of the high desert for many miles north and west of the Faiyum. Some of the trunks measure 70 feet in length.

In spite of the antiquity of these gravels, the vast scale on which they are distributed, and the heights to which they are piled (as much as 400 meters above present sea-level), they are analogous in many ways with the coarser materials under the alluvium of the present Nile delta. The first to recognize this analogy was M. Blanckenhorn, who named the Oligocene river the Ur-Nil.[1] Only a faint idea of the length of time through which this ancestral Nile flowed can be obtained from the still huge sheets of gravel it has left behind, owing to the fact that these have ever since been exposed on a land surface and have been in continuous process of denudation.

Toward the close of the period when this delta was formed, much of the earth's crust in North Africa and the Near East generally was in a state of tension, under the influence of which fissures opened and allowed sheets of basalt to pour out, the magma being in places intruded among the rocks to form sills of dolerite. Small sills are intercalated with the gravels over the region north of the Faiyum, and basalt and dolerite plateaus of the same age cover large areas of Sinai, Palestine, and Arabia, while scattered outliers are mapped also far into the Sahara on the west.

The succeeding chapter in the history of Northeastern Africa is in this region both the most important and the most puzzling of all. It is extremely difficult to read because it is written not in terms of deposits and fossils now accessible, but of erosion and earth sculpture the products of which are lost beneath the present bed of the Mediterranean and the Delta. North of the cliffs in the latitude of Cairo, fossiliferous marine Miocene sediments continued to be laid down in the southern fringe of the Mediterranean, the shore stretching roughly east-west between Cairo and Suez. But by the time the next fossiliferous sediments had been deposited in Egypt south of this latitude, revolutionary changes had taken place and the map of the Near East had already assumed approximately its present shape. The flat North African–Arabian plateau of earlier Tertiary sediments had been elevated high into the air and had been torn by the great rift of the Red Sea and the Gulf of Suez, and the gorge of the Nile had been excavated in it, together with an elaborate system of tributaries. In Upper Egypt the gorge from the top of the bounding cliffs to the rock beneath the alluvium is in places over a thousand feet deep; and in Lower Egypt it has never been bottomed, all borings coming to an end in the gravels of the subsequent filling.

[1] *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, 1902, p. 695.

The earliest deposits (at present visible above ground) to be formed in the Nile Valley were fossiliferous marine strata of Pliocene age. With these marine sediments[1] the history of the Nile Valley as such may be said properly to begin.

Although the gap between the Oligocene river meandering over a plateau and the Pliocene estuary is a complete blank as regards stratal evidence, certain other kinds of evidence may be brought to bear on the problems of the cause and date of the first excavation of the valley.

That neither the valley nor the Faiyum depression is due to faulting all geologists who have seriously investigated the problem are now agreed. The only other likely agent is a great river. It is therefore legitimate to suppose that the Ur-Nil of Oligocene times, after meandering over a much wider tract of country, settled into a definite bed in Miocene times and proceeded to cut down the channel to its present depth. The cause of this cutting-down would have been the uplift of the continent, the effect being to increase enormously the fall of the river. The present course of the Nile would therefore have been determined as the bed which, at the commencement of the uplift, the Ur-Nil chanced to occupy.

The forces required to lift bodily a plateau of many thousand square miles and the pressures set up in consequence are, of course, incalculable. When these forces were relaxed, the land sank to an extent which buried valley and plateau alike under the sea to a depth of first about 170–180 and eventually 250 meters below present sea-level (see chap. iii), a subsidence from which throughout Plio-Pleistocene and Pleistocene times the country has been steadily recovering. It is perhaps significant that the relaxation of pressure over North Africa, following great outpourings of basalt, faulting, and unprecedented uplift, coincides with extensive crumpling of the earth's crust in Southern Europe; for it is generally considered to have been between the Burdigalian and the Helvetian (i.e., Middle Miocene) that the intense folding and nappe-formation of the Alpine ranges took place.

In Egypt, Ur-Nil conditions, giving rise to the "Oligocene facies" of sands and gravels with drifted wood, seem to have continued until the Middle Miocene; for the first typical Miocene rocks to be deposited (limestones with shell banks and coral reefs) correspond in age with the Helvetian and locally with the Upper Burdigalian of Europe. Dr. Sadek has shown that the littoral Helvetian sediments were deposited along the foot of the fault scarps of an already partly formed Red Sea rift valley in the neighborhood of Suez, and they have themselves been subjected to subsequent faulting in an east-west direction. If they ever lapped similarly into the Nile Valley, they are com-

[1] Dealt with in chap. iii.

pletely concealed, while on geological grounds it seems improbable. The evidence points rather to submergence having taken place earlier over the Gulf of Suez region (and its continuation, the Isthmus) than in the Nile estuary, which the sea did not enter until the Middle Pliocene, or the Third Mediterranean period of Suess. In view of the important discovery by Dr. Sadek that in the Suez region the Second Mediterranean period closed with renewed elevation, the Upper Miocene deposits being estuarine and fresh-water, it is probable that the Helvetian transgression over the Isthmus and into the Gulf of Suez resulted from rift faulting, by which the Nile region was unaffected.

While the gigantic task of cutting the valley of the Nile and its numberless tributary gorges may have been started far back in the Miocene, it is probable that the greater part of the excavation was done by the rains of that continental period, between the Second and Third Mediterranean periods, known to European geologists as the Pontic Pluvial period. It was in this interval, spanning the Upper Miocene and the Lower Pliocene, that the great water-courses of Southern Europe were brought into being. With the Third Mediterranean period came renewed transgression, and the waters of the Mediterranean spread far into the mountains, converting the valleys into arms of the sea. In Egypt the new transgression found the valley of the Nile already excavated, and up it the sea made its way for several hundred miles south of Cairo, into the heart of the North African plateau.

It is to the subsequent history of this long arm of the sea and its conversion to a river once more that we must now turn our attention.

III

THE PLIOCENE PERIOD

The stratal history of the Nile Valley as such begins in the region of the Faiyum with the middle of the Pliocene period. Since this was the last geological period immediately preceding the advent of man, it is important to picture the geographical conditions which then prevailed.

So long ago as 1886 the German traveler and scientist Schweinfurth noticed the occurrence of Middle Pliocene marine shells up to a height of from 60 to 70 meters above sea-level on the east side of the desert ridge separating the Faiyum from the Nile Valley.[1] From this he deduced that an arm of the sea at that time occupied the Nile Valley. More recent work in other places by the Geological Survey of Egypt has confirmed his conclusions.

For the first time the Pliocene deposits of the Nile-Faiyum divide have now been mapped and studied (*P* on map). In doing this we have kept two objects especially in view: (1) the determination of the relations of the shelly marine beds to the high-level gravel deposits, and (2) the question of a Pliocene Faiyum, advocated by Beadnell[2] as long ago as 1905 from a study of the high gravels on the north of the depression.

The low-level fossiliferous beds require only straightforward work for their interpretation; but the high-level gravels are usually devoid of contemporary organic remains, and their materials are merely an indestructible residue of older rocks, the appearance of which remains unchanged throughout all periods. Caution is therefore needed before a pronouncement can be made as to the exact age of any particular deposit.

The floor at the sides of the Middle Pliocene gulf consists, wherever seen, of deeply eroded Wadi Rayan and Ravine beds and often of huge slipped masses of these and higher Eocene limestones, over and around which the Pliocene beds were deposited. The slipped masses are often many hundreds of yards in length and may consist of Upper Eocene limestones as much as 150 feet below their original position in a series which, but for them, has since been entirely removed.[3] The slips form parallel lines or crescentic waves, falling toward the

[1] "Reise in das Depressionsgebiet im Umkreise des Fajūm," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, XXI (1886), 96–149, quoted by R. Hanbury Brown, *op. cit.*, p. 38.

[2] *Op. cit.*, p. 78.

[3] *Carolia* beds in slips between Hawara and Lahun, 25 miles south of the present edge of the outcrop.

Nile Valley, but usually dipping away from it toward the cliff from which they have foundered. It may be conjectured that their mode of formation was as shown in Figure 2.

That this great system of landslips had reached a state of quiescence before the Middle Pliocene sea deposited sediments over and around them would seem to point to their being remnants of the Miocene excavation of the valley, brought to a standstill by the sinking of the land and the conversion of the eroding river into a tranquil arm of the sea.

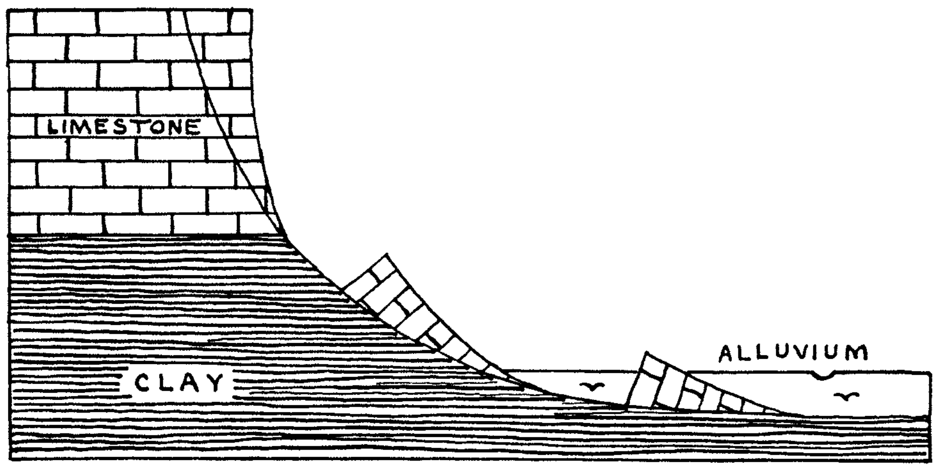


FIG. 2.—SHOWING FORMATION OF SLIPS IN THE NILE VALLEY DURING THE FIRST CUTTING-DOWN IN PRE-MIDDLE PLIOCENE TIMES.

THE FOSSILIFEROUS MARINE PLIOCENE AND ITS RELATION TO THE GRAVELS

Apart from the local filling between underlying slips, the earliest deposit in the Nile Valley in the Faiyum region is a bed of yellow sandstone crowded with beautifully preserved shells of *Pecten benedictus*, *Chlamys scabrella*, and *Ostrea cucullata*. This *Pecten* bed may be followed as a useful datum for tracing the indentations of the Pliocene gulf. Buried altogether by succeeding deposits where deep water existed, it follows the margin of the indentations, bays, and estuaries, rising steeply from cultivation to a maximum height of 100 meters above sea-level. This maximum height is attained in the north of the area (6 km. southwest of the Dahshur pyramids), 70 meters being the usual altitude in the south of the Faiyum region.

The deep-water Pliocene deposits which succeed the *Pecten* bed consist of dark gray or purple clays with a high content of gypsum. Nearer the shore they become sandy and laminated, with layers of round sandstone concretions. In certain localities[1] the deep-water clays contain a highly fossiliferous band of

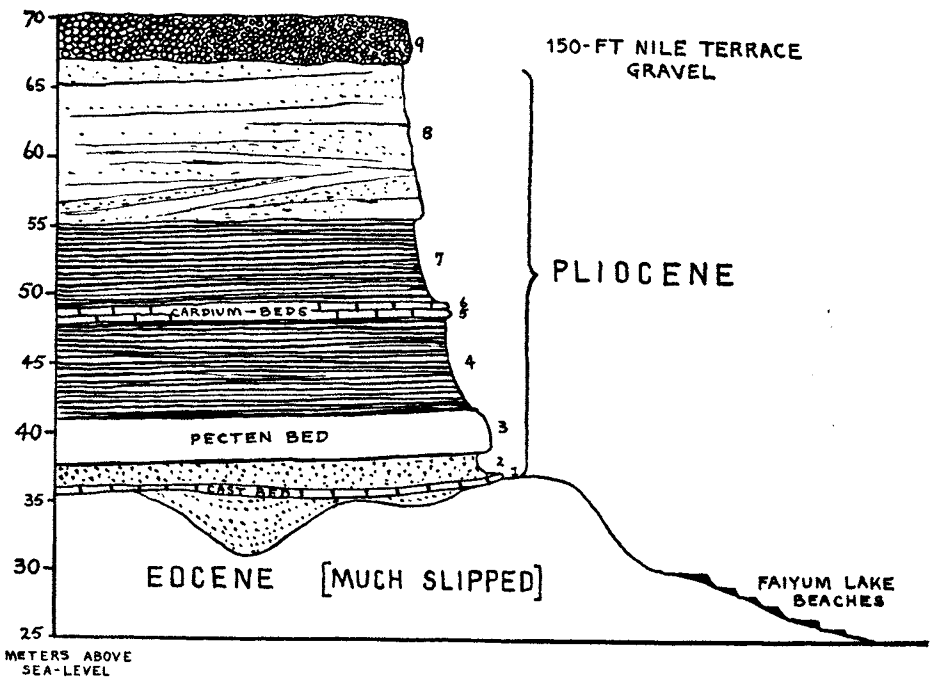


FIG. 3.—SECTION IN THE PLIOCENE AT SHAḲLUF BRIDGE, THE WESTERN EDGE OF THE DESERT DIVIDE BETWEEN NILE VALLEY AND FAIYUM.

	Feet
9. Hard band of coarse gravel, cemented by travertine to form hard conglomerate	6
8. False-bedded yellow, brown, and white quartz sands and sandstones	36
7. Blue and purple gypseous shaly clay, weathering mottled red and brown	21
6. Hard ferruginous limestone with *Cardium subsociale* Blanck., *Anadara diluvii* (Lamk.), etc.	1
5. Brittle porous sandrock, rich in *Cardium linnei* May. Eym., *C. echinatum* Linné, *Meretrix chione* (Linné), *Venus plicata* Gmel., and much selenite	1
4. Blue and purple clay, same as Bed 7	21
3. Two beds of hard yellow sandrock, inclosing a seam of soft yellow sand, the whole crowded with *Pecten benedictus*, *Chlamys scabrella*, and *Ostrea cucullata*	15
2. Yellow sands with tubular markings; locally cemented	6
1. Brown sandrock largely composed of casts of small bivalves (*Mactra subtruncata* var. *elongata?*)	1
Current-bedded sand and detritus filling hollows in the slipped Eocene below.	

hard green ferruginous limestone. From this has been collected a rich fauna indicating by comparison with the rocks of Europe a Middle or early Upper Pliocene age (Plaisancian-Astian).[2]

[1] Ḳalamsha, Kom Tima, Meidum.

[2] From this bed at Kom Tima and Shaḳluf Bridge (see Fig. 3, Beds 5 and 6) we collected the following fossils in some abundance: *Cardium subsociale* Blanckenhorn, *C. echinatum* Linné, *C. linnei* Mayer Eymar, *Arca* (*Anadara*) *diluvii* Lamk., *Meretrix* (*Callista*) *chione* (Linné), *Dosinia lupina*

A branch of the gulf, choked by these deposits, extended from the Nile Valley over the southern part of the Faiyum. The re-excavation and enlargement of the depression have truncated this branch in such a way that a complete section through it may be seen on both sides of the desert ridge separating the Faiyum from the Nile (see Figs. 3 and 4).[1] The sequences on the two sides of the ridge are similar, except that on the Faiyum side the *Pecten* bed at the base remains at a considerable height above the cultivation, its lowest level being about 35 meters above sea-level, whereas on the Nile side it plunges

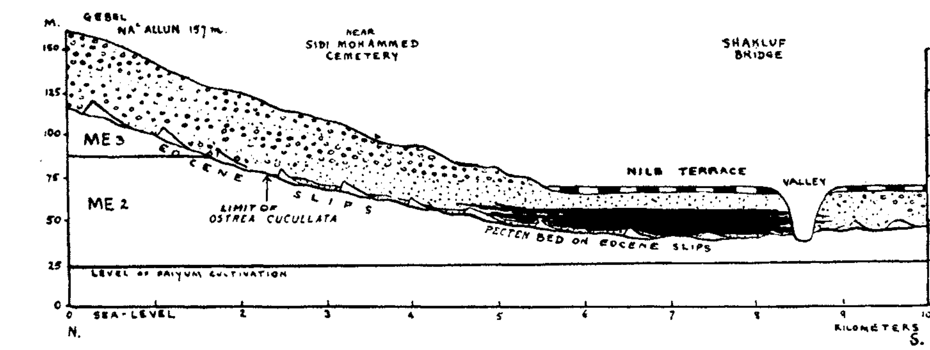


FIG. 4.—GENERALIZED SECTION ALONG THE CLIFFS FROM GEBEL NAALLUN (NORTH) TO THE REGION SOUTH OF ḲALAMSHA (SOUTH), SHOWING THE PLIOCENE DEPOSITS ON THE FAIYUM SIDE OF THE DESERT DIVIDE.

PLIOCENE { gravels, sand, clay } MIDDLE EOCENE { *ME 3* Birket Ḳarun series; *ME 2* Ravine beds }

steeply below cultivation (here about 27 m. above sea-level) to an unknown depth. The water, therefore, deepened toward the Nile, and sufficiently rapidly to indicate that the branch of the Pliocene gulf was not a very extensive one and occupied only a relatively small proportion of the area now forming the Faiyum depression.

In tracing the marine deposits along the cliffs overlooking the Faiyum, the clays in the center are seen to develop laterally a more sandy facies and to pass at the sides into gravelly deposits derived from the denudation of the surround-

(Linné), *Venus (Chamelaea) gallina* Linné, *Venus plicata* Gmel., *Mactra subtruncata* Da Costa var. *elongata*, *Psammobia intermedia* Deshayes, *Tellina* sp., *Neverita josephinia* (Risso), *Natica* spp., *Cerithium* spp., *Dentalium* sp., *Terebratula moysae* Mayer Eymar (also in the *Pecten* bed and near the Meidum pyramid), and a tooth of an elasmobranch fish.

[1] Between Kom Tima and Bahsamun on the Nile side, and between Ḳalamsha and Ḳasr Basil on the Faiyum side. The point that we would particularly emphasize is that the ridge separating the Faiyum from the Nile Valley hereabouts is actually *formed* of dissected Pliocene sediments, instead of their being merely plastered on its sides as previously supposed.

ing land. A wide variety of débris is met with in passing from the deep-water zone outward toward the shore, ranging from such lighter materials as the nummulites and oysters washed in from the Eocene limestones to coarse flint and chert pebbles from the Oligocene. On both sides of the divide the *Pecten* bed passes into oyster banks composed entirely of *Ostrea cucullata,* which seems to have flourished in shallower water than the species of *Pecten.*

Above a height of about 70 meters above sea-level hereabouts all contemporaneous fossils die out, apparently having been swamped by the influx of coarse chert and flint gravel. This gravel continues to rise with the rising Eocene floor until, 30 meters thick and still evidently laid down in water, it forms the summit of Gebel Na'allun, 157 meters above sea-level (Fig. 4 and Plate II, *B*).[1]

The transport of such great thicknesses of coarse gravels is evidence of a heavy rainfall. But there are in certain places at the base of the gravels patches of conglomerate of such coarseness as to demand forces of torrential dimensions. The majority of the blocks in this conglomerate are from 1 to 3 feet in diameter, but some measure as much as 4 meters. All are more or less rounded and mixed with pebbles of all sizes (Plate I). In some places the conglomerate, 15 feet thick, is seen to rest upon false-bedded deposits consisting largely of finely ground Eocene shells; in others it has been forced under ledges of Eocene limestone and fills irregularities in the sea floor. All the constituents of the conglomerate and the gravels are of local origin. Bowlders of *Carolia, Turritella,* and oyster beds from various levels in the Upper Eocene lie side by side with silicified wood and quartz sandstone from the Oligocene. In the gravel the same materials—chert, flint, and quartz—preponderate, with a lesser proportion of black limestone, quartzite, red sandstone, and jasper from the Oligocene.[2]

Since the conglomerate and gravels in places descend to the same level as, and actually pass into, the *Ostrea cucullata* beds,[3] at least the lower portions must be considered to be contemporaneous with them. They are best regarded as torrent and stream deposits shot into the sides of the gulf by local rains.

While at first the water in the center of the gulf was sufficiently deep to permit the flourishing of a marine fauna and the deposition of clays, the gulf eventually became choked with locally derived sediment, coarse sand reaching

[1] Care must be taken to distinguish *Ostrea cucullata* from the similarly ribbed *Ostrea clot-beyi* which occurs throughout the gravels, derived from the Eocene beds.

[2] Near the summit of Gebel Na'allun, at a height of about 130–140 meters above sea-level, are several blocks, about a meter square, of hardened reef corals probably derived from the Upper Eocene.

[3] Best seen in an isolated hill southwest of Kom Tima and in the continuous section above Ḳalamsha.

even to the center (Figs. 3 and 4). At this stage the marine fauna was replaced by an assemblage of stunted brackish-water forms, known as the *Melanopsis* fauna after one of the principal members, a genus of small gastropods, and correlated with the Upper Pliocene. The *Melanopsis* fauna extends as far west as the center of the desert divide, but it has not been collected on the Faiyum side, where it is represented by unfossiliferous black, brown, and white sandstones. This is another indication that the gulf did not extend far over the Faiyum.

Southwest of Sedment the thin-bedded brown sandstones and sands containing *Melanopsis* overlie a remarkable white sandstone rock composed largely of casts of the small lamellibranch *Mactra subtruncata* var. *elongata*. The fossiliferous beds pass into and alternate with local gravels composed of nummulites and oysters derived from the Eocene.

While the inlet extending across the desert divide into the southern end of the Faiyum supplies us with valuable data as to the conditions in the main gulf, now hidden beneath the Nile cultivation or destroyed by the Pleistocene river, for further light on the Faiyum region we must now turn to the other localities where Pliocene deposits are preserved. These fall into the following groups: (1) small bays filled with the marine type of sediment, at a low level along the desert edge flanking the Nile Valley;[1] (2*a*) high-level gravels forming most of the highest hills on the divide between the Faiyum and the Nile; (2*b*) similar gravels extending as spurs from halfway up the high cliffs inside the northern rim of the depression.[2]

THE HIGH-LEVEL GRAVELS

THE HIGH-LEVEL GRAVELS ON THE EASTERN NILE-FAIYUM DIVIDE.—The highest gravel patch on the east of the Faiyum is that of Gebel Naʿallun, already described on account of the exceptional clearness with which its gravels may be followed downward in continuous section until they pass into the fossiliferous marine series. North of the Hawara Channel are four other important outliers, attaining heights respectively of 99, 110, 124, and 144 meters above sea-level. They are referred to in the Survey memoir as Upper Pliocene(?) gravel terraces.[3]

These outliers, like Gebel Naʿallun, are not conspicuously flat-topped, but on the contrary form long narrow ridges, striking west-east across the desert divide, deeply dissected at right angles into sloping minor spurs. The thickness of the gravel varies from about 30 to 60 meters. Such facts show at once that

[1] These do not call for special notice.

[2] These last led Beadnell to postulate a pre-Pliocene Faiyum basin.

[3] Beadnell, *op. cit.*, p. 73.

we can scarcely be dealing with a terrace or terraces in any sense of the word, and that some other explanation is required.

Here the constituent materials provide useful evidence. The lower layers consist almost entirely of local Eocene rubble, often sorted and graded according to size in a remarkable manner. The base consists commonly of rearranged Eocene sands, false-bedded according to the contours of the bottom. The sands pass up into a rubble of yellow limestone fragments or bands of almost pure Eocene nummulites or oysters,[1] which in turn give place upward to an increasing proportion of flint, chert, quartz, and quartzite pebbles derived from the Oligocene. The topmost layers consist almost entirely of Oligocene materials, the number of large pieces of fossil wood from those beds being greater in the northerly gravel outliers. The constituents are therefore of purely local origin, and the earliest to be deposited traveled the shortest distance.

Each gravel ridge rises gradually from Nile cultivation and reaches its highest point near the west end, where it is abruptly truncated in a steep cliff overlooking the Faiyum depression (Plate II, *A*). Fine transverse sections through the ridges are thus available. From these it is apparent that, so far from the gravels forming caps, terrace-like, to the hills, they fill hollows in the underlying Eocene. Along each side of the hollows, buried beneath the Pliocene gravels, is a line of landslips of Eocene rocks fallen in from the walls, like those already noticed in the Pliocene gulf occupying the Nile Valley. Moreover, these slipped masses consist largely of Upper Eocene *Carolia* and *Turritella* beds of which the parent strata have since been entirely removed from the region by denudation, and they therefore indicate that the cliffs bounding the hollows in which the Pliocene gravels were laid down were originally from 100 to 200 feet higher than now. The Pliocene gravels were, in fact, deposited in west-east valleys (see Fig. 5) resembling the Pliocene-filled valleys in Upper Egypt. That they drained, like those of Upper Egypt, into the Nile seems certain from (1) the source of the materials, which can only have been in the west, over what is now the Faiyum, and (2) the fact that opposite the eastern end of three out of the four gravel ridges there can still be seen a bay filled with the marine Pliocene deposits of the gulf. The actual passage eastward from gravels into the marine facies cannot be traced as on Gebel Naᶜallun, owing to the thick mantle of Pleistocene terrace gravels which obscures the critical region. One section is provided by the railway cutting near Ibwit; but here the Pleistocene river has destroyed the Pliocene deposits at the critical point and its igneous gravels rest directly on the underlying Eocene.

[1] Particularly well seen on the cliff on the south side of the railway between Rus and Edweh stations.

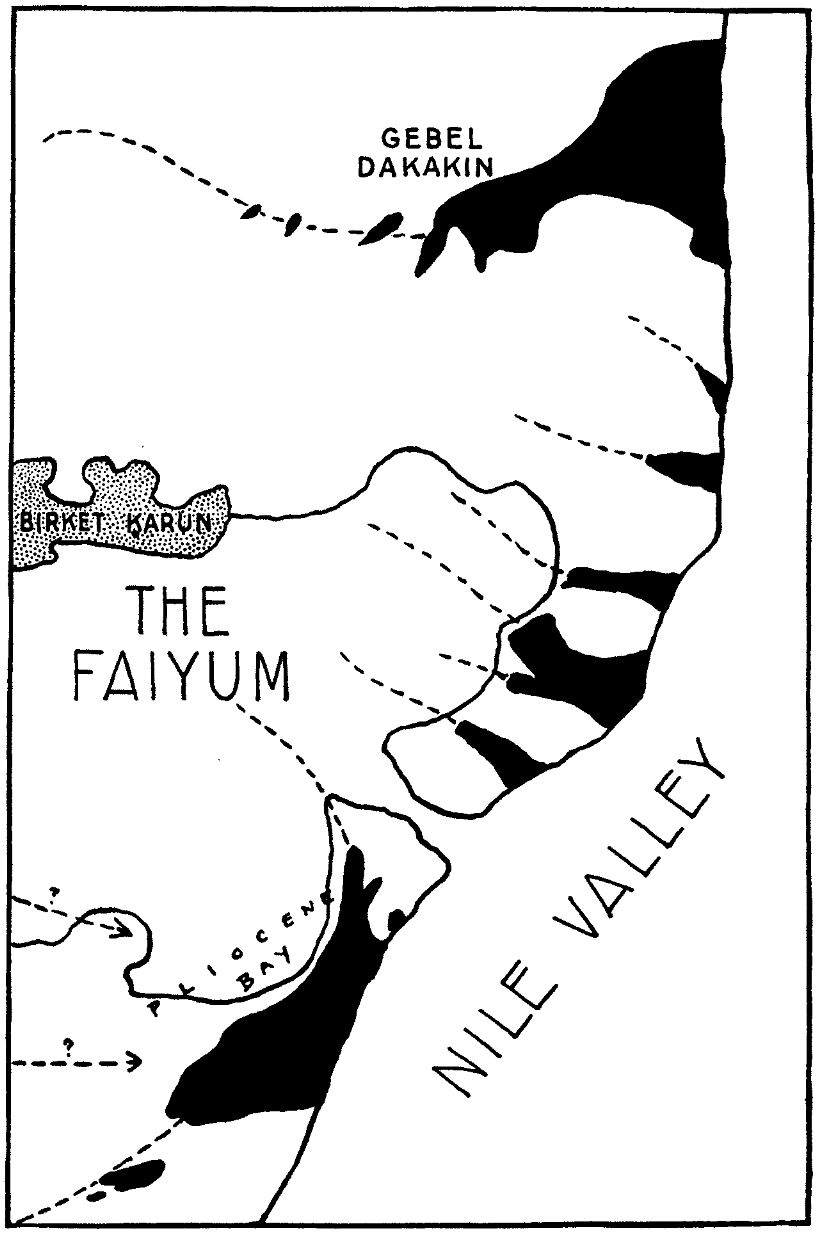


FIG. 5.—DIAGRAM ILLUSTRATING THE PLIOCENE RIVER-SYSTEM DRAINING INTO THE NILE VALLEY GULF. ACTUAL PLIOCENE DEPOSITS BLACK (GENERALIZED); PROBABLE FORMER CONTINUATIONS OF THE GRAVEL-FILLED CHANNELS DOTTED (WHOLLY HYPOTHETICAL). (REDUCED AND GENERALIZED FROM THE LARGE FOLDING MAP.)

The present highest ridges on the east of the Faiyum, then, indicate the positions of the valleys in Pliocene times, and the present valleys were occupied by the intervening plateaus. The reason for this is that the valleys were originally cut in comparatively soft Eocene marls. Once they were filled, however, their virtually indestructible materials so successfully resisted denudation that they began to act as watersheds, while the drainage made for itself new channels in the softer marls between. In particular, the site of the present Hawara Channel, through which the Bahr Yusef enters the Faiyum from the Nile, was probably a high ridge of soft Eocene marls and limestones dividing the two drainage channels the gravel fillings of which now form the ridges on either side. In Upper Egypt it was otherwise. There the Eocene terrane consists of extremely hard limestones, and subsequent drainage has followed the old lines, hollowing out anew the gravel-filled channels (Fig. 6).

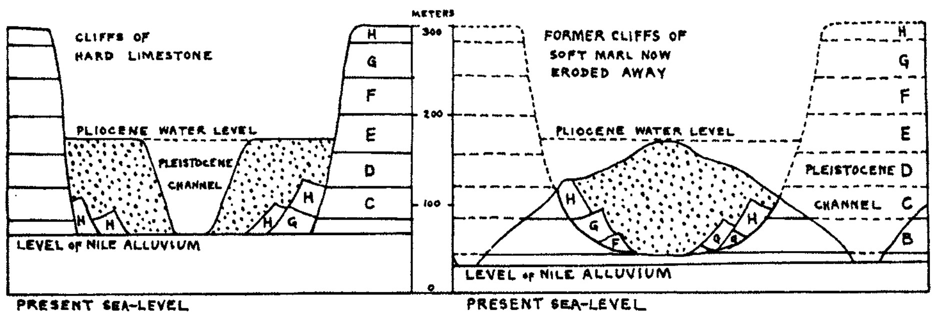


FIG. 6.—DIAGRAMMATIC SECTIONS ACROSS PLIOCENE VALLEYS IN UPPER EGYPT (LUXOR) AND THE FAIYUM REGION. PLIOCENE GRAVELS DOTTED; EOCENE BEDS LETTERED *A–H*.

THE HIGH-LEVEL GRAVELS ON THE NORTHEAST OF THE FAIYUM.—The principal mass of gravels on the north side forms the conspicuous feature of Gebel Dakakin, rising to a height of 201 meters above sea-level, while three small outliers farther west project as spurs from the cliffs of the Oligocene escarpment of Ilwet Hialla (see folding map). The heights of the spurs range from 180 to 190 meters, the escarpment behind rising to 254 meters and the ground to the south sloping gently down below sea-level toward the shores of the Birket Ḳarun. At first sight this chain of gravel spurs seems to be stuck on, as it were, to the inside of the rim of the Faiyum basin; but a closer examination shows that there is another interpretation which is more likely to be the correct one.

The present spurlike form of the gravel outliers is due to the southerly drainage into the Birket Ḳarun. It is easy to picture them as originally joined in an east-west chain, for they are still connected by surface débris of the larger silicified tree trunks which denudation has failed to remove. But when we suppose them to have originally extended as a vast plateau southward over the Faiyum at the great height of 180 to 200 meters, the question arises: Where has this vast reservoir of indestructible material gone? The gravel deposits in the Faiyum today are quite inadequate to account for it, while the lake bottom throughout Pleistocene times consisted always of silt or sand. Furthermore, it is impossible to believe that all except this chain of spurs has suffered denudation, for we have learned that elsewhere it is the surrounding country that has been denuded, while the Pliocene gravels have remained.

When we come to examine the north-south sections through the gravels, we find no outward (southerly) slope of the base; on the contrary, the bottom is furrowed with channels, as much as 15 and 20 feet deep, running west-east, or parallel to the supposed shore line. The appearances are, in fact, similar to those of the valley sections on the eastern Faiyum divide (see Fig. 7). More-

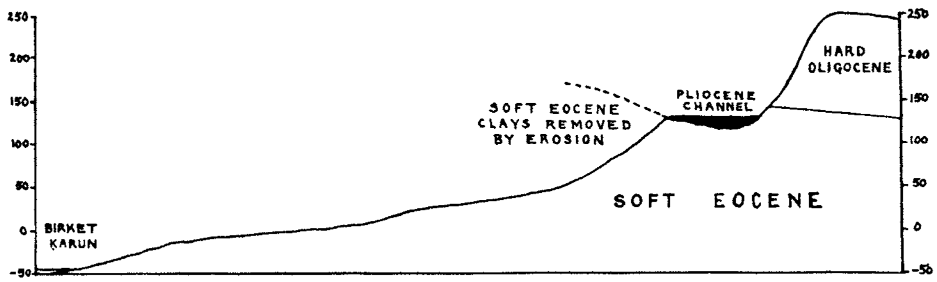


FIG. 7.—DIAGRAMMATIC SECTION THROUGH THE UPPER REACH OF THE PLIOCENE DAHSHUR PYRAMIDS VALLEY FROM BIRKET ĶARUN TO ILWET HIALLA (THE OLIGOCENE ESCARPMENT).

over, the grading of the materials is west-east, not north-south, from shallow into deeper water. The gravels of Gebel Dakakin are similar to those of Gebel Naᶜallun and the other outliers at the same distance from the Nile, but the smaller patches farther west consist of much larger blocks of silicified wood and sandstone from the Oligocene. This fact clearly indicates an easterly current. At the same time it is incompatible with a direct northerly origin of the materials, since the Oligocene escarpment passes behind all these northerly outliers alike and the source would in that event have been everywhere at the same distance, no west-east grading having occurred.

The study of the other west-east valleys has already accustomed us to picture the Faiyum basin in Pliocene times not as a basin but as a high plateau of Eocene rocks, dissected by a system of watercourses flowing eastward into the Nile. It is no surprise, therefore, to find that it is merely the remains of another such watercourse that form these northern spurs of gravel (cf. Fig. 5).

That the western extremity of this valley alone has been partly preserved may be attributed (*a*) to its greater size and (*b*) to the protective action of the resistant Oligocene on its north side. It was, in fact, a strike valley, following the junction of the Upper Eocene and the Oligocene, formations of very different resisting capacity. Eventually, while the northern (Oligocene) wall of the valley remained, retreating only a short distance from its original position, the southern (Eocene) wall completely disappeared. The Pliocene filling, consisting chiefly of re-sorted Oligocene materials, was of a hardness intermediate between the two and has been partly destroyed and partly left.

The gravels of Gebel Dakakin, about 30 meters thick, can be traced northeastward in continuous section, falling steadily toward the Nile Valley, until they merge into an estuary, filled with rubble and clays, opening immediately south of the Dahshur pyramids. Near the pyramids the *Pecten* bed is seen at the northern edge of the estuary, dipping steeply from a height of about 30 meters above sea-level southward under the clays. On the southern side of the estuary it emerges once more, with an opposite dip, and can be followed at intervals to a height of 100 meters above sea-level.

Altogether, the remains of seven rivers have been found which flowed in Pliocene times from the Libyan Plateau into the Nile gulf in the region of the Faiyum. Enumerated from north to south with their principal characteristics, they are as follows:

a) *Abusir Pyramids Valley.*—No special topographic features, but the marine facies (the *Pecten* bed) can be traced up continuously into the gravels through a great thickness of false-bedded sands and sandstones at the mouth.

b) *Dahshur Pyramids Valley.*—Mapped and traced continuously up to Gebel Dakakin, and just described. Between this and the northernmost valley the *Ostrea cucullata* bed forms a gray limestone 30 to 40 feet thick, a much more massive marine rock than was formed anywhere farther from the mouth of the gulf on this side of the Nile.

c) *Lisht Pyramids Valley.*—Of minor importance. The gravels now reach only halfway across the Nile-Faiyum divide, having been planed off during one of the Plio-Pleistocene stages of the Nile. The passage from the marine facies to the gravels is obscured by Pleistocene gravel.

d) *Meidum Pyramid Valley.*—Finely truncated on west at Ezbet Hanna Salih (see Plate II, *A*, and Plate VII, *B*). Passage from gravels to marine facies obscured by Pleistocene gravel.

e) *Gebel er-Rus Valley.*—The largest of all the valleys except the second. Besides Gebel er-Rus itself, a second block of Pliocene hills south of the railway is included, as it is probably a relic of a tributary which joined the Rus Valley somewhere east of the railway station. The *Pecten* bed is exposed in the east end of the railway cutting near Ibwit, but between here and Rus station the Pleistocene stage of the Nile has removed the Pliocene entirely and Nile gravel rests directly on Eocene (seen in Plates I, *A;* VI, *A;* VII, *A*).

f) *Gebel Lahun Valley.*—A very conspicuous and typical gravel ridge on the north side of the Hawara Channel. No marine end of the estuary now remains, it having been removed by the Pleistocene Nile.

g) *Gebel Naᶜallun Valley* (described on pp. 14–15 and illustrated on Plates II, *B*, and I, *B*).—It flowed south-southeast into the branch of the gulf which stretched over the southern part of the Faiyum. The gravels can be traced down continuously into the marine facies.

THE WATER-LEVEL IN THE PLIOCENE GULF

From the foregoing pages it will have been apparent that, excepting a bay or flooded estuary of probably inconsiderable extent on the southeastern side, the Faiyum basin as such was not in existence in Pliocene times. The region at that period formed a part of the northern Libyan Plateau of Upper Eocene and Oligocene rocks, draining normally eastward into the marine gulf which occupied the Nile Valley.

The height at which the water-level stood in the gulf is not easy to determine. The highest level at which marine shells have been found is 100 meters above sea-level, but bedded débris and gravels evidently laid down in water reach much greater heights. The conception of these gravels as choked valleys exempts us from supposing the sea to have attained such a height as 201 meters (Gebel Dakakin). Indeed, had the country been mountainous, they might have extended upward indefinitely.

There is, however, a limit to the angle at which such wide valleys can have sloped toward the sea, however torrential the rainfall. It is inconceivable in a plateau country that the bedded gravels at the top of Gebel Naᶜallun were laid down, 30 meters thick, to a height of 157 meters while the sea stood at 100 meters only one mile away. The marine shells hereabouts reach a height of only 70 meters, but we would incline to the view that the summit of Gebel Naᶜallun was submerged by the sea when its gravels were deposited, making the sea-level at least 170 meters. Only by supposing the gravels to have been shot into the still water of an estuary is their great thickness satisfactorily accounted for.

Another extraneous piece of evidence points to a similar Pliocene sea-level: In Upper Egypt the hard limestones of the Lower Eocene plateau have remained as high cliffs towering over the Pliocene gulf, the deposits of which are banked against their sides to a height of about 170 meters, where they terminate with a flat top.

On the whole, then, we think about 170–180 meters to have been the most likely sea-level in Middle–Upper Pliocene times. The height at which marine fossils occur increases northward (70 m. at Sedment, 100 m. at Dahshur) and we expect that when investigations are carried north of Cairo, into the region of the open sea, it will be found that the full height of the Pliocene sea-level can be proved directly.[1]

[1] Since sending this to the press we have completed a season's work north of Cairo, in the Delta region. An extensive mass of Pliocene gravels has been found, forming Gebel Mansuriyeh, with a flat top at about 170–180 meters above sea-level; and a similar level has been found to be indicated by the highest occurrences of thick Pliocene deposits on the Suez road east of Heliopolis. Near Gebel Mansuriyeh Pliocene limestones, with *Pironella conica*, attain to about 130 meters above sea-level; and the limestones also pass upward into gravels at about this height near the Suez road.

IV

THE PLIO-PLEISTOCENE TERRACES

In course of time the Pliocene gulf seems to have become more or less completely choked with sediments of the various kinds described, after which a great change came about. We find extensive sheets of gravel brought 250 miles and more from Upper Egypt. The pebbles have been followed to their sources of origin, which are threefold:[1] (1) the Nubian sandstone region south of Luxor; (2) granitic regions of the Red Sea Hills, supplying many colored pebbles of red granitoid rocks and red and purple porphyries; (3) metamorphic and ancient volcanic rocks of those hills, supplying purple and green tuffs, green epidote rock, chlorite schists, etc. For the first time the Nile has taken up its rôle as the dominant feature of the valley, cutting terraces in both the Pliocene and Eocene deposits and covering them with sheets of far-traveled materials.

The gravel on the highest terrace yet found (*PP 1* on map) stands at a height of 164 meters above sea-level, or 470 feet above the Nile; and five succeeding spreads of the same gravel at successively lower levels form a continuous series and bring us to the middle of Paleolithic times.[2] The determination of the heights of the terraces will be more accurately achieved when a wider area has been investigated, but provisionally the principal stages seem to group themselves as follows:

Feet above Nile		Meters above Nile
470– 440	or	143– 134
395–?365	or	120–?110
320– 265	or	98– 80
210– 180	or	64– 55

More than two of these terraces are but rarely preserved together, and in places they are all unrecognizably blended in a continuous slope of gravel. Occasionally favored localities are found, however, where the terraces stand out with exceptional clarity (see map).

Of the highest two terraces (*PP 1* and *PP 2* on map), relics have been found in only one locality, to the west of Dahshur, where their preservation is probably connected with the Oligocene and Pliocene rocks on which they are

[1] K. S. Sandford in *Quarterly Journal of the Geological Society* (London), LXXXV (1929).

[2] The heights of terraces are measured above the adjacent flood plain as datum (= "above Nile"). The principles involved are discussed in the *First Report of the Prehistoric Survey Expedition,* "Oriental Institute Communications," No. 3.

situated. These have protected them from the undermining action of the weather, which has removed all trace of their former extension over the soft Eocene country.

Here also the next terrace is magnificently developed, the greater part of it lying between heights of 250 and 300 feet, but rising at the margin as a thin skimming of gravel on the hills up to 320 feet (Plate III). From here northward it forms a vast spread of Nile gravel, which extends to the borders of Abu Roash and the high plateau behind the Gizeh pyramids (*PP 3* on map). Farther south it is represented by isolated patches only. These have been hitherto mapped as Pliocene, but an examination of the materials instantly suffices to distinguish them.[1]

The maximum development of the lowest barren Plio-Pleistocene terrace within the area, that at 180–210 feet above Nile, is attained south of Gebel Naᶜallun, where it occupies the whole of the highest part of the Nile-Faiyum divide for 10 or 12 miles southward to Gebel Deshasheh (*PP 4* on map). Implements have been carefully sought at many points within this area, but always with negative results. Whether the Nile during this westerly meander ever flowed over any part of what is now Faiyum cultivation it is difficult to say, but it certainly occupied the whole width of the present desert divide. This terrace is also a prominent feature at the foot of the higher plateau from Saḳḳara to Gizeh.

It is probable that the major part of the lowering of the plain, which was to give rise eventually to the Faiyum depression, took place during the period of these high terraces. The physiographical changes wrought by erosion since the period of the earlier ones, however, are so enormous that it is impossible to picture with any close approach to the facts the aspect of the country at that time. The stage at which the whole of the Faiyum drainage first came to be concentrated through the Hawara Channel may never be determined, but it was probably at or about the period of the 210–180-foot terrace. None of the early stages of the drainage system has left any recognizable mark in the Hawara Channel or in any other outlet to the Nile Valley.

What was the cause of the sudden change of conditions, so greatly augmenting the carrying capacity of the Nile that it began to bring down coarse gravel in place of fine mud? It can scarcely have been an increased rainfall, for, as has been shown, the rainfall was already exceedingly heavy in Pliocene times. The most likely explanation seems to be a drop in the level of the sea or a rise of the land, resulting in an increase in the fall of the river and an accelerated cur-

[1] There are two patches northeast of Philadelphia, on the edge of the Eocene escarpment overlooking the Faiyum, and a third, resting on Pliocene, on the southeast shoulder of Gebel er-Rus.

rent. The eroding and carrying capacity of the river was, we know, kept constant until at least Middle Paleolithic times by periodic changes in the relative levels of sea and land. By then the river had cut down almost to its present level and yet was still bringing the same kind of material.[1]

Although it was to be expected that these movements would prove to have been of widespread occurrence, it was with considerable surprise that, on compiling our leveling data, we found that a general correspondence was established with the stages found by General de Lamothe in Algeria.[2]

The stages in the two regions may be tabulated as follows:

Nile Meters		Algeria Meters
143– 134	....	148
120–?110 / 98– 80	....	108–93
64– 55	....	60–55

Still higher stages (325 m., 265 m.,[3] and 204 m.) are stated to occur in Algeria, but they do not concern us here. There are also terraces of less elevation, to which we shall give our attention in due course. De Lamothe's work was based on the study of the raised shore lines and beaches of the Mediterranean, to which he found the terraces of the river Isser bear a close relation.

It remained for Depéret to combine De Lamothe's and others' work with his own studies of shore lines and to produce his well-known chronology of late-Tertiary and Quaternary times.[4] His generalized figures there include stages of 100–90 meters and 60–55 meters, to which he applied the terms Sicilian and Milazzian, respectively, and the former lies *unconformably* upon beds of Upper Pliocene age.

The figures which are now for the first time available from Egypt are admittedly provisional, but even so they are valuable; and as we pass northward

[1] Since this was written, we have made discoveries in the western Delta which call for modification of the argument contained in this paragraph. On Gebel Khashab and Gebel Hadadin, the highest hills in the region, we have found small remnants of the gravels of still higher Nile terraces up to 250 meters above sea-level (233 m. above Nile). These show that the movements between Pliocene times and the first appearance of igneous gravels from the Red Sea Hills tended to further submergence before the initiation of the great period of elevation.

[2] L. J. B. de Lamothe, "Note sur les anciennes plages et terraces du bassin de l'Isser (Département d'Alger) et de quelques autres bassins de la côte algérienne," *Bulletin de la Société géologique de France*, 3. sér., XXVII (1899), 257–303, and "Les anciennes lignes de rivage du Sahel d'Alger et d'une partie de la côte algérienne," *ibid.*, 4. sér., XI (1911), *26–28.*

[3] This stage would now seem to be represented in Egypt.

[4] Charles Depéret in the *Comptes rendus de l'Académie des sciences*, Paris, 1918 ff., and elsewhere. See especially his "Essai de classification générale des temps quaternaires," *International Geological Congress*, 13th sess., Brussels, 1922, pp. 1409–28 (published in 1926).

intermediate stages may reveal themselves. In particular, the two groups 120–110 and 98–80 may fall into three, about 120, 100–90, and about 80 meters or less. That is, there may be Nile stages, not recognized elsewhere, above and below the supposed Sicilian stage.[1]

On the northern side of the Mediterranean the 100–90 group is of post–Upper Pliocene age; in Egypt also we infer it to be Plio-Pleistocene, since we know it lies unconformably upon Upper Pliocene beds. Here, then, lies an important foundation for our chronology. We would lay stress on the existence of even approximately similar stages in such an important part of the seaboard as that surrounding the mouth of the Nile, the greatest of Mediterranean rivers. No evidence, either confirmatory or conflicting, has previously been available from Egypt.

[1] As a result of our last season's work in the Delta region we have some indication that the terrace we have referred to above as the 64–55-meter terrace may elsewhere resolve itself into two groups, one at about 70–60 meters (230–200 ft.) and another at about 45 meters (150 ft.) above Nile. These heights must be considered as only provisional until the whole Lower Nile has been investigated.

V

THE PLEISTOCENE PERIOD

INTRODUCTION: THE LOWER PALEOLITHIC STAGE

Within the boundaries of the region which we are investigating in this paper we cannot draw a line of division between Plio-Pleistocene and Pleistocene times, and it is doubtful if it will be possible to do so in any part of the Nile Valley. The physiographical changes and meteorological conditions which mark the close of the Pliocene period herald the advent of the Pleistocene Nile and continue with little modification until Middle Paleolithic times.

We find an impressive series of terraces, and as we pass from one to another we note the same signs of an immensely powerful Nile carrying northward the rocks gathered by its Upper Egyptian tributaries from far-distant sources. From beginning to end the river is cutting its way deeper into the marine and estuarine deposits which fill its sunken Miocene valley. But the downward movement is marked by pauses, of which we cannot gauge the duration. Four of these we have noted in chapter iv; the fifth we are about to consider.

We gain some idea of the time factors involved in these periodic excavations and outspreadings of enormous fields of coarse gravel in two ways:

1. Between the fourth and fifth stages Man not only appeared in the district for the first time but passed through two of the most important, and probably most prolonged, phases of his advancement.

As already mentioned in the last section, the Plio-Pleistocene gravels are devoid of all trace of human handiwork, however crude; but the fifth stage (*PT* on map) provides a mixed assemblage of Lower Paleolithic implements. We would hope to find a series of terrace gravels containing each a slightly more advanced type of implement, so that we might follow an evolutionary chain from crudest Chellean to the highest example of Acheulean skill. We would hope then to pass by further stages, yet more delicately marked, into the realm of Mousterian (Middle Paleolithic) Man, with his revolutionary methods of making stone implements. But, although we may find this elsewhere, within the region which we have investigated all save the last are grouped together in one great gravel-stage.

From this we learn, first, that the time interval between the fourth and fifth stages, though they are separated by a vertical distance of barely a hundred feet, is to be reckoned in scores of thousands of years. Second, we shall note that the lower gravels are but a *remanié* of countless deposits which have been destroyed. This is shown by the implements themselves, for the older types (cf. Fig. 8) are more waterworn than the younger; they had a long and varied history of exposure, incorporation in alluvial deposits, and redeposition before they came to rest where we find them. The very fact that they are available to us means that the gravel containing them is now in process of destruction and redeposition in the modern Nile, a phase of erosion virtually brought to a standstill during the existence of desert conditions.

It is an important fact that the younger implements—rare examples of beautiful Acheulean work (cf. Fig. 9)—are almost as fresh and as sharp as on the day of their manufacture. They probably mark the completion of the fifth stage in Acheulean times. That being so, we might be disposed to look upon the older implements purely as derived material from older stages, to ignore them, and boldly to describe this as the Acheulean terrace. When we have pursued our search farther north, south, and east, this suggestion may be justified by the discovery of relics of a Chellean terrace.[1] At the moment, however, we have no direct evidence of the Nile occupying any other course than that of the fifth stage between its desertion of the fourth and completion of the fifth in later Lower Paleolithic times. It is conceivable that the river had already reached the lower level before Chellean Man appeared; and, until we can prove to the contrary, we must accept the possibility. Thus we shall be well advised to follow the less adventurous and perfectly truthful course of referring to the fifth simply as the Lower Paleolithic stage.

Such a distribution of implements relieves us of the difficulty of distinguishing Pleistocene from Plio-Pleistocene deposits.

2. Some conception of the magnitude of the time scale is conveyed also by a study of the levels of the earlier stages. The fragmentary Plio-Pleistocene gravel terraces bordering the east side of the Faiyum show that at the time when they were being formed the river spread far beyond the bounds of the present valley walls. Moreover, they testify to deltaic conditions, showing that the mouth of the river with its delta was then situated not far from the region of the Faiyum. As elevation continued, the river began to cut down in its bed, thereby restricting itself within valley walls of its own making, and at the same time the delta advanced continually northward, the relics of the former deltas being left high and dry far from the mouth. By Paleolithic times the river had cut down some 400 feet and was confined within its gorge, much as at the present day, while the delta began, as at present, near Cairo. The period of time necessary for such changes to be brought about must be acknowledged to be immense.

[1] Cf. the important discoveries by Père Bovier-Lapierre at Abbasiyeh, a Cairo suburb, described in *L'Anthropologie*, XXXV (1925), 37–46.

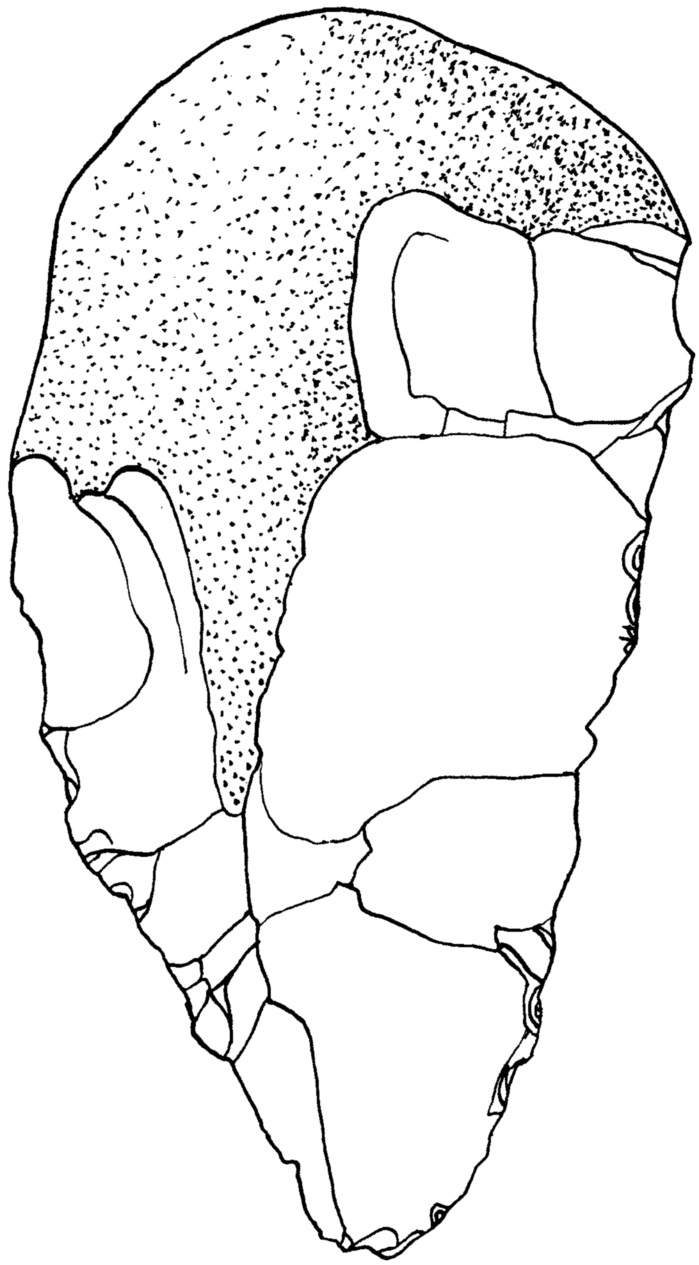


FIG. 8.—CHELLEAN *Boucher* FROM LOWER PALEOLITHIC GRAVELS NEAR KOM TIMA. NATURAL SIZE

We shall now return to the fifth Nile terrace, which we have already learned to be of Lower Paleolithic (Chellean and Acheulean) age. Its general level lies at about 85–70 feet, or about 26–21 meters, above the modern river. This falls

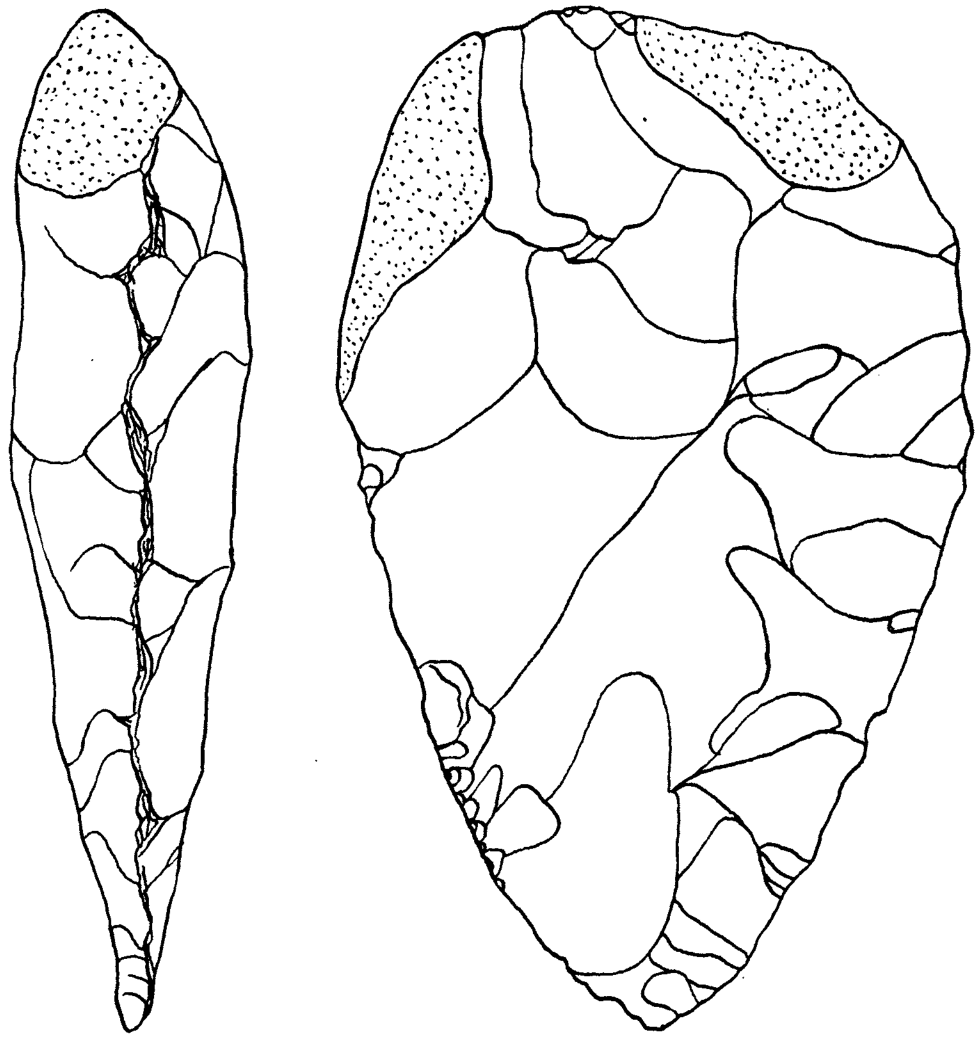


FIG. 9.—ACHEULEAN *Boucher* FROM LOWER PALEOLITHIC GRAVELS NEAR KOM TIMA. NATURAL SIZE

between the heights of two of the Mediterranean stages of Depéret, whose classification[1] continues as follows: 35–30 meters (Tyrrhenian stage),[2] 20–18 meters (Monastirian stage).

[1] *Op. cit.*, p. 1410.

[2] 30–28 meters along the Isser in Algeria; cf. *ibid.*, p. 1414.

The former (about 100 ft.) is generally looked upon as the terrace in which Chellean implements may be incorporated. It occurs in Upper Egypt with such implements, and in Lower Egypt these are now found in *rolled* condition in slightly lower gravels which contain also slightly rolled Acheulean types.

We may justly claim to have provided useful confirmation of the earlier part of Depéret's important and much-debated chronology, and work over a wider field may establish the later part also. Light upon it is particularly to be desired in Egypt, in a terrane which has not been subjected to the violent vertical movements and volcanic disturbances which, even in Quaternary times, have affected much of the Eastern Mediterranean littoral. For purposes of research within the country, we have already secured a datum and a chronological standard of comparison of more than local application, and of the greatest importance because the figures were obtained from subsequent analysis. We did not go into the field armed with them and seeking only to prove their existence—a frame of mind which almost invariably produces the required result.

THE DEPOSITS OF THE LOWER PALEOLITHIC STAGE.—Remains which suggest conditions at this period are as follows:

a) *In the Nile Valley*, along the west bank from south to north of our region, a magnificent longitudinal section of the Lower Paleolithic river bed is exposed (see *PT* on map). The gravels, fully 60 feet thick, afford sufficient warning of the vital necessity of using only *marginal* deposits for fixing the height of a river stage with reference to modern level. We cannot speak of these gravels, therefore, as a "terrace," such a feature appearing only in their marginal outliers. In general they sweep down from about 70 feet or a maximum of 85 feet, until they are truncated by the present alluvium-filled channel or until they reach the old river bed. A true gravel-terrace is formed when a marginal deposit has been truncated by later river erosion (e.g., in Upper Egypt).

The first outlier is near Bahsamun. Toward Sedment, which stands upon the gravels, we gain the first indication of a broad river pursuing a sinuous course, and a short distance north of the town there is a magnificent section cut by the Bahr Yusef (Plate IV, *A*).[1]

It was between Sedment and Kom Tima that implements were found in the

[1] This was originally a stream running between the edge of the desert and the higher parts of the alluvium which lie nearer the Nile, drawing its water from the alluvium and acting as a natural drain. It has been canalized, however, since dynastic times, its original meandering course being preserved, and has been of vital importance in historic times as the supplier of water to the Faiyum basin. At and about Sedment it runs close along the desert edge, which ends steeply, and the Lower Paleolithic gravels are consequently well displayed.

gravels, and near Sedment is the critical section referred to above. The gravels, consisting of a high percentage of large igneous pebbles mixed with abundant quartz sand, lie on a strongly eroded surface of Pliocene beds of laminated sandy clay. In its southern part the section is improved by extensive quarrying of the quartz sand and gravel (of which the base is not seen). The river bed is clearly seen to pass to the west of the smoothed and furrowed hummocks of Pliocene strata. A little farther north, the Pliocene beds rise to the full height of the cliff, and the whole of the channel lies on the desert side, i.e., remote from the Nile; it soon reappears, however, and sweeps on toward Kom Tima. Pliocene beds are frequently exposed beneath it, and its gravels thin out as the bed shapes the course toward Gebel Abusir. This "island" of desert opposite the mouth of the Hawara Channel is covered by, and probably owes its existence to the protection afforded by, the older Pleistocene gravels.

At the mouth of the Hawara Channel the marginal gravels have been almost completely removed; but relics are seen beneath Kom Medinet Ghurab at its southern margin, and they thicken near by, quartz sand being a prominent constituent.

North of Gebel Abusir the river bed is beautifully displayed in a sinuous curve winding across the desert as far as Lisht (see map).

On its Nileward side also (near Ibwit) the flanks of the channel rise toward the former eastern bank of the river. Standing here, one is impressed by the grand proportions of the stream which once hurried coarse gravel from the Red Sea Hills of Upper Egypt along its bed. The state railway from Wasta to Medinet el-Faiyum traverses the river bed at its broadest part, and its dreary wastes of gravel desert are well seen from the train. The mid-desert station of Rus is the center of extensive quarrying of the gravels for railroad ballast, and for convenience we refer to this as the Rus Channel. The ballast pits afford a petrological museum of large pebbles of red, green, and purple rocks from the Red Sea Hills, in fresh condition.

At the Meidum pyramid the center of the channel is cut once more by the modern course of the Nile, and its irregular base, on eroded Pliocene and Eocene surfaces, is well exposed in numerous sections.

Just north of the Darb Gerzeh a slight change in its course takes the channel's center back into the desert, and here in some large excavations were found remains of the Lower Paleolithic molluscan fauna: *Corbicula artini* Pallary, *Mutelina aegyptiaca* Pallary, and *Unio gaillardoti* Bgnt.—all species still living. We found no vertebrate remains.

Here also we see traces of more tranquil conditions in lenticles of silt, several feet in thickness, among the coarser gravels. No better opportunities for studying the conditions of the bottom of the ancient Nile could be afforded than by sections such as these, and full use was made of them.

At Lisht, a little north of this point, the center of the channel passes once more out of the desert and we do not see it again. From a point south of the Dahshur pyramids, however, to Saḳḳara we see a considerable part of the western side of the river bed and its western margin, here a uniform terrace-feature on which stand the pyramids.

Such was the course of the Lower Paleolithic Nile, a broad, fast-flowing river with a carrying capacity out of all proportion greater than that of its muddy survivor.

b) *In the Hawara Channel* we found no trace of this stage, though particular search was made for it. The disposition of the gravels at and about the mouth suggests that the channel is of later Plio-Pleistocene age.

c) *Within the Faiyum* we should note an isolated spread of gravel for which we cannot definitely account. It is situated on the west side of Gebel Naʿallun in the neighborhood of a Coptic monastery (near Ezbet Ḳalamsha). As might be expected, prominent screes sweep down from Naʿallun and fan out on the soft Eocene slopes. At their feet, however, the material assumes a more ordered arrangement, covering the Eocene clays to a depth of about 4 feet, roughly bedded, and, in common with all surfaces in the region, cemented by gray travertine to form a crust which may be exceedingly hard (here, for the greater part, it is more friable). Below the crust, which is rarely more than about 3 feet thick, the material is loose. Taken as a whole, the spread has the appearance of having been deposited in water; and its uniform upper limit (150–160 ft. above sea-level) accords with the height of the Lower Paleolithic terrace in the Nile Valley. The suspicion is further strengthened by the infrequent presence of Lower Paleolithic implements of indeterminate type which *may* be weathering out of the gravel, though no positive proof of this was obtained. The slope has been greatly dissected in later times. Its state of disintegration coupled with its isolated position and the non-occurrence of similar spreads elsewhere along the eastern side of the Faiyum prevents a decision as to its true nature being made. We can do no more than record it as the first deposit which may have been formed in the waters of a lake in the Faiyum basin. The absence of any such occurrence in the Hawara Channel gives us no encouragement to go beyond this simple statement of fact.

THE MIDDLE PALEOLITHIC STAGE

So far as the Faiyum is concerned, no period was more critical than this. Denudation by normal subaerial agents, as described in the earlier chapters of this paper, had continued until by now the district was reduced to a low plain of soft rocks. Its river system had been tributary to the Nile, and, although diligent search has been made for another channel by which the drainage waters might have passed, none has been found.

The obvious possibilities of each of the existing low cols have been explored with negative results; there is no indication whatever that any of them acted as a river course or as an overflow channel Nileward at any time. Each of them seems to have been a water-parting for streams flowing on one side to the Faiyum and on the other to the Nile, and they probably owe their present low level to the erosion of these streams.[1]

We are thus forced to look upon the Hawara Channel as the sole connecting link, at any rate since early Paleolithic times. We know that it was cut in soft Eocene rocks between the two gravel-protected ridges of Gebel Naʿallun and Gebel Lahun. Certainly it could not have been excavated when the Faiyum was already a lake, unless the waters were ponded behind it until they spilled over and brought about its destruction by waterfall and cataract. Of this there is no evidence; and ponding would have thrown into use one or more of the cols already enumerated.

The natural explanation is that the waters of the Faiyum river system found their way into the Nile Valley over the site of the Hawara Channel when the soft Eocene beds were not yet eroded. The channel was then excavated fairly rapidly but in harmony with the general lowering of the surface of similar beds exposed over the Faiyum. In other words, the deepening of the channel kept pace with the lowering of the drainage basin behind it until both lay far below the top of the resistant beds. This is not a rare process, but it is of interest in Egypt. It is similar to the Medway's excavation of a gorge through the chalk North Downs of Kent, England, so that the river, which now rises (in the Weald) below the escarpment, nevertheless pierces it and remains a tributary of the Thames.

From a consideration of levels it transpires that the process could have started in mid-Plio-Pleistocene times, and it probably continued through Lower Paleolithic times.

The high gravels which flank the channel are derived from the Pliocene beds above it. They may or may not have been formed in terraces during the earlier stages of the Hawara stream, but any such order has been destroyed by the denudation of the Eocene beds beneath them.

[1] The dry cols are as follows: (1) to the south of Ḳalamsha and Sedment, (2) immediately north of Gebel Lahun, (3) the valley occupied by the Faiyum-Wasta railway line, (4) the Darb Gerzeh valley, (5) many miles farther west, between Ilwet Hialla and the dolerite sills, a region of monoclinal folding and of faulting.

By mid-Paleolithic times the river system of the Faiyum seems to have reduced the whole area, save the cliffs of the Ḳasr es-Sagha series and the Oligocene, to a base level of gentle slope.

The relation of the Wadi Rayan to the Faiyum system in pre-mid-Paleolithic times would be an interesting and profitable subject for research. The suggestion might be hazarded that the wadi was then, as now, the upper end of Wadi Muellih, that it captured some of the headwaters of the Faiyum system and drained into the Nile some considerable distance to the south of our region.

Here again we should note a gap in the sequence of Paleolithic implements which is not at first apparent. We have seen that the 85–70-foot gravels bring us to a fairly advanced stage of Acheulean culture, and we might reasonably expect to find in a succeeding stage implements of Micoque, Levallois, or even normal Mousterian types, all of which occur in Upper Egypt. We find none of these, but instead implements of markedly "late" Mousterian type, suggesting even a gradation to the next succeeding Paleolithic industry. It emerges that a considerable section of the Upper Egyptian terrace-stages and industries is missing both in this part of the Nile and in the Faiyum. If the industries had been represented in gravels of higher level, we should expect to find them re-derived in later stages;[1] but we do not. The alternative suggestion is that they lay a little *below* the level of the final Mousterian gravels which are preserved. We suggest that this was indeed so in the Nile Valley; that the Faiyum system accommodated itself to the level; and that, when a slight rise of the river's course took place before the close of Middle Paleolithic times, the Faiyum was at once flooded via the Hawara Channel. It is certain that the lower parts of its drainage basin became a lake at this time, that they remained as such throughout Paleolithic times, and that the Nile itself was responsible for the inundation.[2]

The probability of the suggestion made above is brought home when we study the location of the surviving patches of gravel containing Mousterian implements with relation to the Lower Paleolithic Rus Channel. A more favorable position could not be found for the occurrence and preservation of gravels intermediate between the formation of the channel itself and the Mousterian stage. Diligent and purposeful search discovered none. Nor do the Mousterian gravels seem to penetrate into the center of the abandoned channel, although in parts of its course it is certainly low enough to receive them. Instead, we find them in isolated patches associated with the truncated flanks of the channel

[1] Cf. the rolled Chellean implements in what is probably an Acheulean stage.

[2] Cf. discussion of Hawara Channel, p. 38.

along the margin of the modern alluvium. It seems that the Rus Channel was abandoned permanently before Mousterian times and that, within the confines of our region, the Nile had by that time adopted much of its present course, overflowing and destroying any intermediate gravels which it had formed. The few surviving marginal patches, of "late" Mousterian age, occur to a height of about 20 feet, or a little more, above present alluvium level.

This terrace carries us beyond the boundaries of local work, for its height (about 8 m.) is one definitely recognized by Depéret to be of widespread importance as a post-Monastirian stage. Once more we make contact with a sequence of general application; and as the work proceeds to north and south, we may anticipate that such bonds as these will be strengthened.

The deposits of the Mousterian stage.—Survivals from this period occur as follows:

a) *In the Nile Valley,* within our area, gravels containing Mousterian implements are limited to certain marginal terraces, patches of only a few square miles in extent, but important out of all proportion to their area. Two of these are of essential bearing upon the Faiyum and its problems: (1) near Kom Tima (118 ft. above sea-level), (2) near the Coptic monastery of Lahun (117 ft. above sea-level). They are on the south and north sides, respectively, of the mouth of the Hawara Channel. Farther north there are other patches, of less importance, e.g., a few miles south of Ibwit (119 ft. above sea-level). The gravels rest at the foot, or on the flank, of the Lower Paleolithic channel deposits, forming a succession of low spurs running toward the modern alluvium and some 20–25 feet above it. Their gravel contains a high percentage of local rocks and far-traveled pebbles from the older deposits, in general of smaller size than those which we have met previously. At Lahun the gravels are also banked in a long succession of spurs against the local downwash fans. At both sites implements are numerous and are found *in situ.* Some of the low-lying gravels of Gebel Abusir are probably of this stage, but implements were scarce and were found on the surface only; for the greater part, these gravels certainly belong to the older stage.

b) *In the Hawara Channel* we realize the importance of the two sites just described; for at Dimishkin, about halfway along it, and on *both* banks, the Mousterian gravels reappear in prominent, flat-topped marginal terraces. The material of which they are composed is finer than at Kom Tima and Lahun; *but it is derived from the Nile, not from the Faiyum.* That is, it is essentially a Nile gravel, with abundant igneous rocks, and derived mainly neither from the Pliocene beds which flank the channel nor from the Oligocene strata which lie within the Faiyum. This is a fact of the greatest importance, equaled only by the discovery that, on both banks of the channel, *the terraces sink toward the Faiyum,* where they pass into shoals and a magnificent beach, with a storm beach behind it. The gravels also contain a molluscan fauna, characterized by *Corbicula artini,* which is abundant in them both here and within the Faiyum.[1]

For the first time, therefore, we meet unequivocal evidence of the Faiyum basin as a great lake *filled by the Nile.*[2] It is difficult to overestimate the importance of this discovery to the long-discussed history of the basin. The facts were adduced solely by prolonged and accurate leveling, coupled with a meticulous care in following the gravels themselves within and outside the channel and differentiating them from all other deposits, local or far-traveled.

The principle is best shown by a comparison of the levels of the gravel-terrace in the Nile Valley and of the beach within the Faiyum. In the deposits of both we have found abundant Mousterian implements, as we have in the connecting gravel of the Hawara Channel.

From the heights already given (p. 37) we may take the summit of the Nile terrace to be 118 feet above sea-level opposite the mouth of the Hawara Channel. From the records obtained within the Faiyum and to be discussed shortly, we estimate the height of the water-level of the Mousterian lake to have been at 112 feet above sea-level. Along the channel a number of confirmatory levels have been measured, from which we can draw a profile (Fig. 10). The only aberrant records are those of the storm beaches, which were piled up to 123 feet above sea-level in the funnel-shaped outfall of the channel into the lake. These are strictly in conformity with the levels of storm beaches along the whole eastern shore of the Mousterian lake. We are thus led to conclude that in Mousterian times the Nile supplied a rapid flow of water to the Faiyum and that its surface level fell about 5 feet in passing from one end of the Hawara Channel to the other.

The question immediately arises: What happened to the inflowing water?

In the first place, it covered an enormous area to a considerable depth (*vide* the size and height of the storm beaches, and the size of the waves required to pile them up). No doubt some of the water was removed by seepage into the soft rocks and some by evaporation, though the climate was not then desert and (judging by the fauna) the water remained fresh.

The fall of 5 feet should be noted. Evidently at the time of maximum flow the lake was substantially lower than the Nile level; but probably it did not

[1] A few specimens were found at Lahun, and they are abundant in the patch of gravel near Ibwit.

[2] Since our publication of this fact in *Nature* (April 28, 1928, p. 670), Miss Caton-Thompson in *Geog. Journal,* LXXIII (1929), 52, has stated that it is obvious.

oi.uchicago.edu

remain so. When the two were equal, only silt would be deposited in the channel, and if the level of the Nile fell, that of the lake would fall with it. The speed of the reversed current in the channel would depend upon the rate of fall of the Nile, a pure time-factor, and the volume of water to be discharged from the lake to restore equilibrium. If the rate of fall was gentle, no deposit or perceptible erosion might result within the channel, and no gravels of reversed slope.

Turning again to the geological evidence, we find no gravels of reversed slope, and, as already stated, there is no evidence that any other route of escape from the lake was employed at any time.

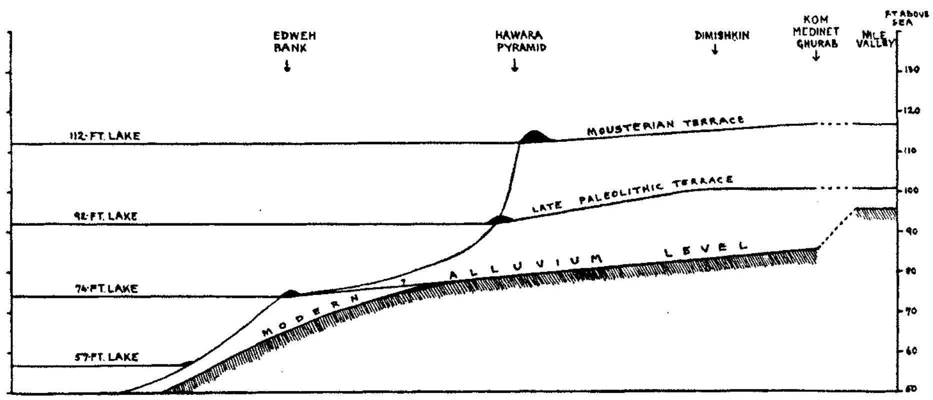


FIG. 10.—LONGITUDINAL SECTION ALONG THE HAWARA CHANNEL, SHOWING THE RELATION OF THE TERRACES AND BEACHES. VERTICAL SCALE GREATLY EXAGGERATED.

Evidently the local rainfall still supplied by the remaining parts of the old Faiyum river basin was insufficient to maintain the water-level and the lake "leaked," or a part of the Nile would not have poured down a slope to fill it. On considering the whole of the possibilities, we think it is probable that a certain amount of this leakage was Nileward again through the Hawara Channel, that the 5-foot drop indicates replenishment under optimum conditions, that the fall of lake-level and its re-elevation were probably annual—in fact, that there was an annual Nile flood and annual low Nile. This might be expected on other grounds which we shall investigate.

c) *Within the Faiyum* we shall now describe the great Mousterian lake. No doubt its beaches could be traced without difficulty round the entire basin, but our object was primarily to tie the basin to the Nile Valley and unite the history of each in a single and consecutive account. In the Nile Valley, at least in this part of Lower Egypt, the history of events and of Man becomes obscure after Mousterian times, when it is beginning to be traceable in the Faiyum. There is thus an invaluable overlap which allows the two to be dovetailed together. The Faiyum basin becomes henceforth an integral part of the Nile system, not a tributary system as of old, but an overflow reservoir into which the Nile discharged its surplus waters.

Our researches were on this account confined to the east side of the basin, from a little northwest of Philadelphia to the south side of the Gharaḳ basin. In reconnaissance beyond these limits the beaches are seen to continue, but, especially on the northwest, to die down until only spreads of gravel and finally lake silts and clays remain.

On the east side of the basin, then, we meet the Mousterian beach in its maximum development, rising in certain localities into a storm beach which lies behind and 10–15 feet above it.

When we look into the relations of beach and storm beach, certain other features attract our attention. Both types occupy bays (mostly in the soft Eocene country between the denuded Pliocene wadi-conglomerates); they are absent or fragmentary at the "headlands." In the bays their curves are markedly symmetrical. Their surfaces are smooth and regular, and in every way the beaches are homologous with marine deposits of like origin.

There is no evidence of a coastal drift, the material being supplied locally, except that Nile gravel is disseminated for a few miles on either side of the Hawara Channel. This material is also locally abundant in situations remote from the channel. In such cases it is derived from the relics of Plio-Pleistocene terraces which cap the Nile-Faiyum divide.

A combination of the facts mentioned above admits of the following deductions: (1) The prevailing strong wind was westerly, as now. (2) At times great gales swept over the lake. (3) The gales occurred when the basin was well supplied with water, probably annually.

Now the annual Nile flood reaches Cairo in late summer, and conditions may have been similar in Mousterian times. Thus it may have been early autumnal gales that swept across the Faiyum lake, then at high level. Strong winds still cross the basin from westerly origins (southwest to northwest); but on the shores of the shrunken survivor of the old lake, now hidden far below sea-level, they produce a storm beach barely a foot high and consisting chiefly of cockle-shells.

The conditions of Paleolithic times are realized if we imagine a shifting of the main storm-tracks of the Mediterranean a little to the south. Beyond doubt this occurred, especially under the influence of still existing ice-sheets in the Alps and Pyrenees. That the gales came from the west when the Faiyum lake was full in Paleolithic times is not merely of local interest but of fundamental importance to the study of Quaternary meteorology.[1]

It is not our intention to distract the reader with a mass of local details, but we cannot ignore the needs of those who may desire to go over the ground. We shall therefore make a cursory examination of the Mousterian beach from north to south, and the reader will be enabled to follow us by reference to the map.

1. All round the great bay near the southern end of which the ruins of Philadelphia are situated, a great shingle bank runs between the cultivation and the Eocene cliffs. This is crowded with shells of *Corbicula artini*, *C. innesi*, and *C. consobrina*, and in the corner an exceptionally well-preserved stretch under the south headland shows us vividly what was the probable water-level of the lake. On the landward side of the storm bank are low flats of Eocene clay.

2. In the first bay south of Philadelphia the beach is fragmentary, owing to the destruction of the soft Eocene clays on which it lay. Under the northern cliff, however, it is well displayed, contains abundant implements, and is well suited for leveling purposes (see below).

3. Between the two steep spurs of Gebel er-Rus is a small bay providing one of the most important sections (Plate V, *A*, and Plate VI, *A*). Here the material is unusually coarse, being derived from the Pliocene conglomerates in the immediate vicinity. Implements are abundant along the shore line itself, many of them coated, like the shingle in which they are imbedded, with thick, soft travertine and clay. *Corbicula* shells also are abundant in and among these nodule-like masses. From the Pliocene hills behind, a prominent gravel fan slopes downward and covers the beach to a thickness of several feet. Flakes, cores, and completed implements found on this well-preserved beach removed any doubt that Mousterian Man had occupied it. Its level was therefore of especial importance.

4. South of Gebel er-Rus the Mousterian lake beach sweeps in an unbroken curve for about 9 miles to the mouth of the Hawara Channel, into which it turns below the north end of Gebel Lahun. It was in this wide bay that the waves gathered their greatest force and piled up a long bank of shingle to a height of 15–19 feet above the normal water-level (131 ft. above sea-level). The *Corbicula* shells imbedded in this storm beach belong principally to the species *C. artini*, but *C. innesi* and *C. consobrina* also occur (Plate IV, *B*). The shells collected here are in an advanced state of abrasion, having been rolled and

[1] Further observations of interest to meteorologists will be found in later sections of this paper (e.g., pp. 44, 52, 54, 56, 67–69).

pounded among the shingle by the waves. The pebbles retain a polish on which the sun glints almost as though the beach were still wet. Standing on the top and looking along the 9-mile sweep of the ridge, it is easy to picture the Faiyum as the Mousterian people saw it, covered by a vast lake extending to the horizon. Behind are extensive hollows, then probably occupied by sheets of water and marshland.

At the north end, where the beach closes in against the cliffs of Gebel er-Rus, it is covered by a downwash fan of gravel brought down in more recent times from the Pliocene gravels above.[1]

At the south end the shingle bank tapers off into a number of curved spits which trend round into the opening of the Hawara Channel. The longest of these is the outermost, which runs toward the pyramid of Hawara. It has been marked on the map, but only approximately, for it fades gradually at the extremity, where it was continued under water. The rolled and rounded *Corbiculae* are so numerous as in places to whiten the ground (as in Plate IV, *B*). Within the channel the shells of *Corbiculae* are fresh and unworn and may be collected with their two valves still united, witnessing to the protective action of the shingle spits against the westerly winds.

5. South of the Hawara Channel conditions such as those described above continue till we reach Ezbet Ḳalamsha. A mile or two farther south the true beach, unbacked by any storm beach, is banked against the truncated ends of the 150–160-foot gravel-spread already described (p. 34) as a possible Lower Paleolithic lake beach. Deep gullies here cut through the Mousterian beach to the underlying rock, and it is beautifully displayed. Unfortunately, in this one locality it is devoid of both shells and implements. Its upper surface is extremely regular (Plate V, *B*).

6. In a mile or two the beach leaves the cliffs and sweeps across an open plain once more. The storm bank at once reappears and, in almost unbroken curve, both continue for many miles. They may be seen behind Ḳalamsha and onward past Ḳasr Basil to Tebtunis and beyond.

Near Shaḳluf Bridge is one of the low passes between the Faiyum and the Nile (from Ḳalamsha to south of Sedment). We have already mentioned (p. 35) the lack of evidence that any of these was used as an outlet for the waters of the Faiyum lake, and our belief that they were excavated by streams of the Nile-Faiyum divide. Here both impressions are definitely confirmed by a prominent gravel-fan or small delta which has been built out into the Mousterian lake by the stream flowing from the col. The material is of local origin,

[1] The same conditions obtain at the north end as in the miniature bay to the north (par. 3, on p. 41), but here no implements were found.

and its upper surface, conforming to the level of the Mousterian lake, forms a small but prominent plateau. The bedding and sorting of the material are characteristic of deltaic deposits in still water.

Near Ḳasr Basil Mousterian implements are unusually abundant, in by far the richest site known to us in the Faiyum. They are quite fresh, unworn, and unpatinated, and are found *in situ* in silt and beach gravel. As this exposure is unusually perfect and presents some features not seen elsewhere, we shall describe it in some detail (see Fig. 11).

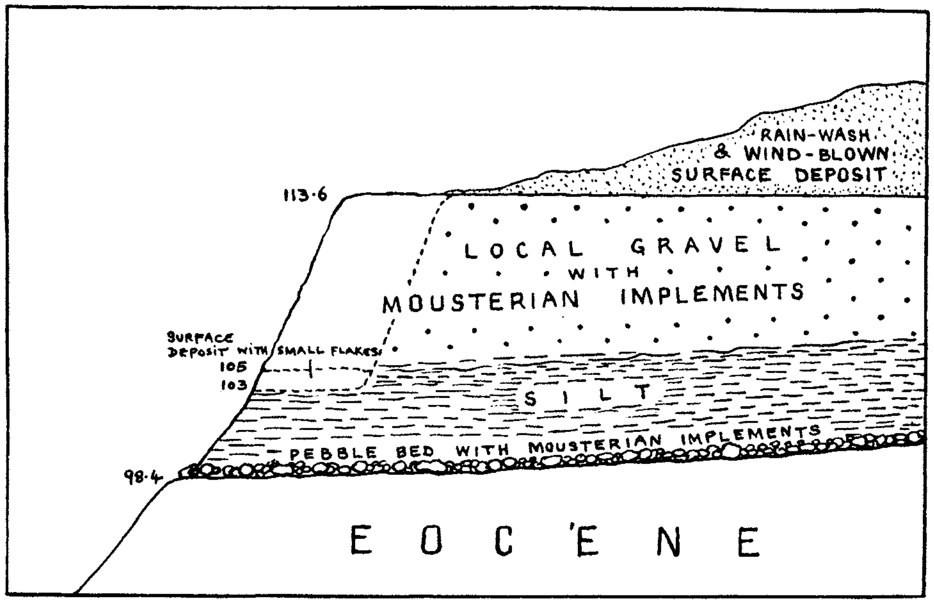


FIG. 11.—SECTION IN MOUSTERIAN BEACH DEPOSITS NEAR ḲASR BASIL (TUTUN)

There is a basal conglomerate, of local Eocene rocks derived from the Pliocene gravels behind, rising somewhat in the direction of the cliffs. It provides Mousterian implements in abundance. It is covered by lake *silt* containing implements, above which gravels and silt rise to 113.6 feet, where there is a prominent "flat" or terrace feature. Implements and shells are abundant throughout. It should be noted that the silt contains flakes of white mica (muscovite) brought into the lake by the waters of the Nile.

This series is covered by a great thickness of wind-blown dust, finely bedded and full of mica flakes and comminuted shell fragments (no unbroken specimens were seen), interbedded with surface wash from the hills and cliffs behind.

Conclusive evidence of the aeolian origin of this material is provided by its mounting high up a gap or valley in the cliff behind; i.e., it has been drawn scores of feet up a wind funnel and is there interbedded with rain wash from above. It is locally cemented by gypsum and contains selenite concretions.

Another feature of interest is seen in the deep, narrow, and meandering gullies which have subsequently cut through the whole thickness of gravel and silt. Their sides are flanked by gravel which has every appearance of being a part of the beds cut by the wadi, i.e., the Mousterian beds; but in reality the greater part of this material has been deposited by the torrents which deepened the gullies. It has been covered by scree material and is distinguishable from true gravel-beds only with great difficulty. Much of it is hardened to form a rock of iron-like resistance, but in truth it is only a sheath to the gully and protects soft silts which otherwise would have been destroyed.

The presence of a dune belt on and behind the beach, and of thick silt beds, should be noted in this situation, the southeast corner of the lake.[1] We are not yet beyond the action of direct wind, however; for the beaches continue beyond Tebtunis until they die away in the great Eocene plain beyond.

The extent of the lake in other directions was not our immediate concern, and we curbed our impatience to follow it into Wadi Rayan. We are of the opinion that the waters of the lake flooded this depression, and are indebted to Mr. O. H. Little, director of the Geological Survey of Egypt, for the information that *Corbiculae* occur at the critical height on the watershed between it and the Faiyum.

Levels.—The following accurate determinations of height are typical:

	Beach (In Feet above Sea-Level)	Storm Beach
South end of Philadelphia bay	.....	121.0
Implement site, Gebel er-Rus	111.5	
Near Wasta-Faiyum railroad	.....	130.7
East of Hawara pyramid	.....	127.1
Southeast of Dimishḳin	.....	123.4
Ezbet Ḳalamsha	109.5	.....
Ḳalamsha Monastery	110.3	.....
Ḳasr Basil	113.6	.....

An average of beach levels (water-level) may be taken as 112 feet, and of storm-beach levels 120–130 feet, above sea.[2]

It cannot be too strongly emphasized that the water-levels in this and the

[1] Cf. the silts developed a few miles northwest of Philadelphia.

[2] Sea-level is the most convenient datum. The height of the modern lake varies continually, being controlled by the needs of irrigation, i.e., by the amount of water allowed to pass into it through the system of canals and drains.

succeeding lakes were probably subject to considerable variation. Although exact measurements to the nearest tenth of a foot were taken of carefully selected beaches and other features at intervals, the heights vary from 109.5 to 113.6 feet, giving an average of about 112 feet. This corresponds within 6 inches with the height of the most satisfactory feature of all, at the implement-bearing site at Gebel er-Rus.

Notes on the Mousterian implements.—In view of the fact that each season's work adds substantially to the amount of material at our disposal for comparison and description, we feel that it is of little service to attempt a comprehensive analysis in this paper. Each year new light is thrown upon the development of the Mousterian industry in particular, and there is good reason to suppose that considerable gaps yet remain to be filled. A full account, based on the large amount of material already found in geologically dated strata, would be rendered obsolete by the following season's work. We realize, however, that the paper would be incomplete without *some* account of the artifacts, and in these few notes we attempt to steer a *via media* between obvious need and obsolescence caused by our own further efforts.

In Upper Egypt we have already noted a considerable diversity of form, and distinguish (*a*) an early Mousterian (Levallois) of coarse flakes and heavy tortoise cores and (*b*) a more advanced industry, essentially Mousterian, but itself varying considerably. These two are found in strata of dissimilar age.

In Lower Egypt we have not yet noted the early Mousterian types, but we find sufficient similarity to couple those forms which occur with the second, "typical" Mousterian industry of Upper Egypt.

Greater diversity of form is, however, a notable feature here and points to a late Mousterian age for part at least of the implements from strata, since it leads to Sebilian (Late Paleolithic) forms which we shall discuss later.

We are dealing with the beaches of a lake and the border-gravels of a river, ideal spots for settling down to the business of making implements, since water, food, and (in certain localities) the material for fashioning implements lay ready to hand. Judging by the localization of the material which we found, we were dealing with such working-floors, and this is reflected in our collections. Despite careful search, finished flakes are in the minority, while cores and flaked pieces of cortex and coarse and often broken flakes abound. Finished flakes may be found scattered over the adjacent deserts in about equal proportion to the cores from which they were detached. In other words, the finished product is but rarely found where it was made, and we have to judge the industry in considerable measure by its cores. Fortunately, these are characteristic and display interesting variations.

Figures 12 and 13, from Rus, show a type of Mousterian core common in Egypt, sharply triangular, with a prominent "beak" (*B* in Fig. 13) which in some instances is worked to form a blunt boring-point after the core has been used for its initial purpose of providing a flake. Flakes are removed in two ways, as shown in the figures. In the normal method (Fig. 12) a single flake is struck off, the platform usually being roughly faceted; in the figured example the attempt has failed, and only a scar and a useless flake resulted. Economy

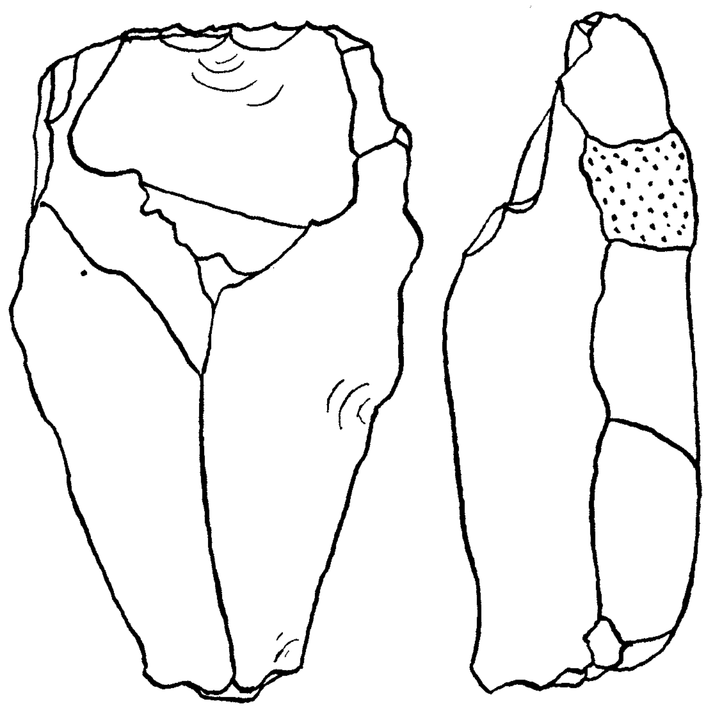


FIG. 12.—MOUSTERIAN CORE FROM THE 112-FOOT BEACH NEAR GEBEL ER-RUS. NATURAL SIZE

was observed by an alternative method (Fig. 13), the blow intended to remove the flake being directed near one end of the platform so that the core would produce a second flake struck off parallel to the first.

The flakes, when detached, are sharply pointed with a ridge, usually as a median rib to the flake, which adds greatly to the strength of the point. The striking-platform may or may not be prepared. The flakes produced from this type of core (e.g., Fig. 13) are frequently without retouch; the strong and sharp point alone seems to have been required.

An adaptation of the normal triangular core is seen in Figure 14. The method is the same and the variation lies in the choice of a fairly thin piece of

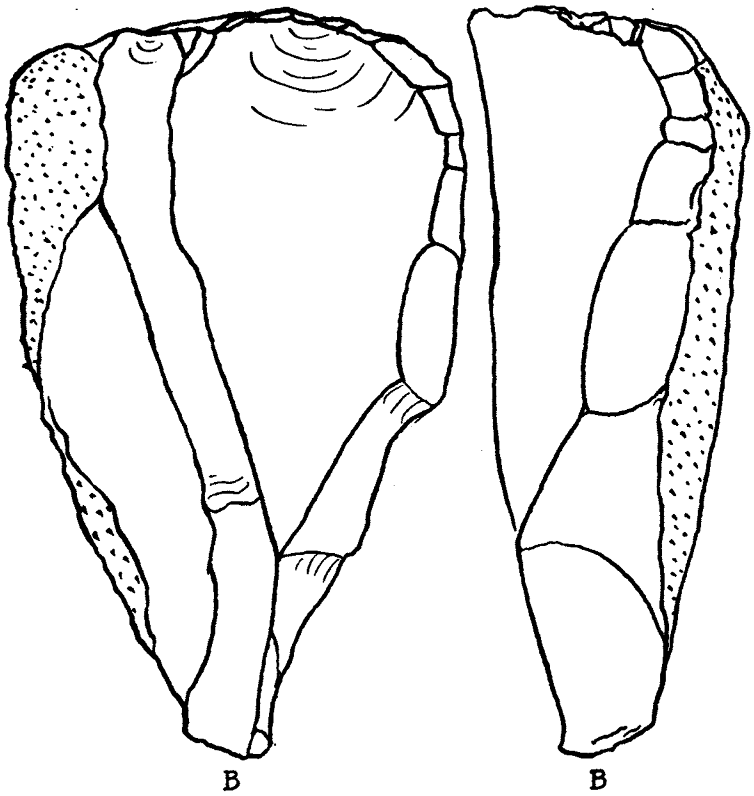


FIG. 13.—MOUSTERIAN CORE FROM THE 112-FOOT BEACH NEAR GEBEL ER-RUS. NATURAL SIZE

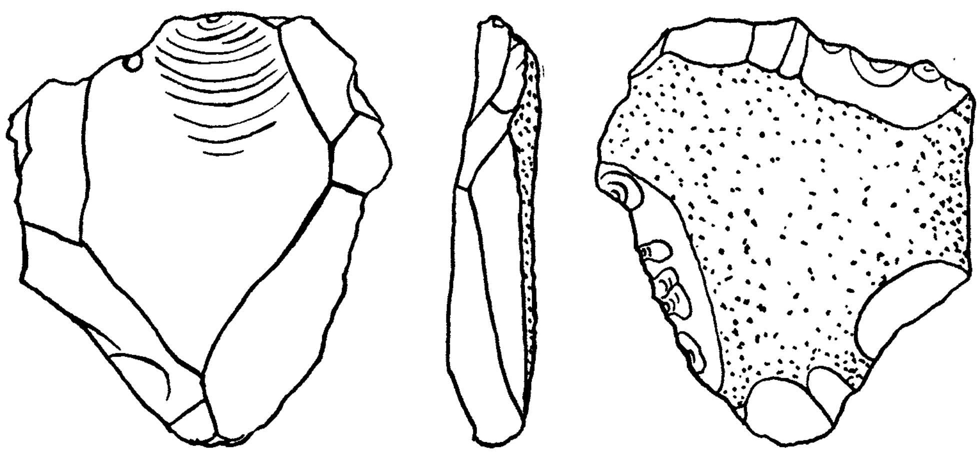


FIG. 14.—MOUSTERIAN CORE FROM THE 112-FOOT BEACH NEAR GEBEL ER-RUS. NATURAL SIZE

tabular flint or chert. Only one flake can be prepared from each core, and it is considerably broader than the foregoing type. Such flakes usually have faceted butts, as the more slender core needed careful preparation. The median rib is replaced by an elevated polygonal area, the strength of the point being in no way diminished (cf. Fig. 18, Nos. 1 and 2).

The type of Figure 15 follows naturally from that of Figure 14. Some attempt at triangular outline is usually retained, and tabular flint was selected. The type passes insensibly to Figure 16, in which the triangular outline is lost. Before the flake is removed, the prepared core is nothing more nor less than a disk. Disks are common implements on the desert surfaces of Egypt, and various purposes and ages have been assigned to them. Some of them we can now demonstrate to be Mousterian cores. This we believe to have been their original function; but they would certainly be useful weapons in the chase, and they may have been utilized as such in the first place merely as waste products and later have passed to this service alone, no flake being detached.

The flakes from the cores of Figures 15 and 16 are somewhat similar to those of Figure 18, Nos. 1 and 2. Their breadth and length depended solely on the size of the core; and, being devoid of the median rib, they are not of unwieldy thickness. It was also a simple matter to retouch them and remove the raised polygonal area and the bulb of percussion, highly finished flake implements being produced (cf. Fig. 18, No. 3).

Perhaps through the plan of Figure 16 we reach the most interesting type of all (Fig. 17), which is characteristic of some of the sites we have investigated. We have found it *in situ* side by side with Mousterian flakes and cores of more common type and have no doubt whatsoever of its association with that industry. It may be described as a *double-ended core*. Its distinctive features are as follows: (*a*) It was made from a flat pebble or a piece of flint thin in proportion to its length. (*b*) The flint was trimmed to rectangular or square outline, opposite ends (Fig. 17, *A* and *B*) being specially "prepared" by flaking at a high angle, usually from one side only. If convenient, one of the other two sides was left untouched (Fig. 17, *C*), and that opposite to it (Fig. 17, *D*) was trimmed parallel to it. (*c*) A flake was then detached from *each* of the two "prepared" platforms. Many of the flakes are short in proportion to their width and have parallel edges, but not infrequently the worker obtained two long flakes (cf. Fig. 17). The flakes seem to have been the objects desired, and we have no evidence of the further use of these peculiar cores. From the larger cores it would be a simple matter to make the "crescents" which are outstanding in many of the collections of implements from the desert surface about Thebes. We may have more to say about this in a later paper.

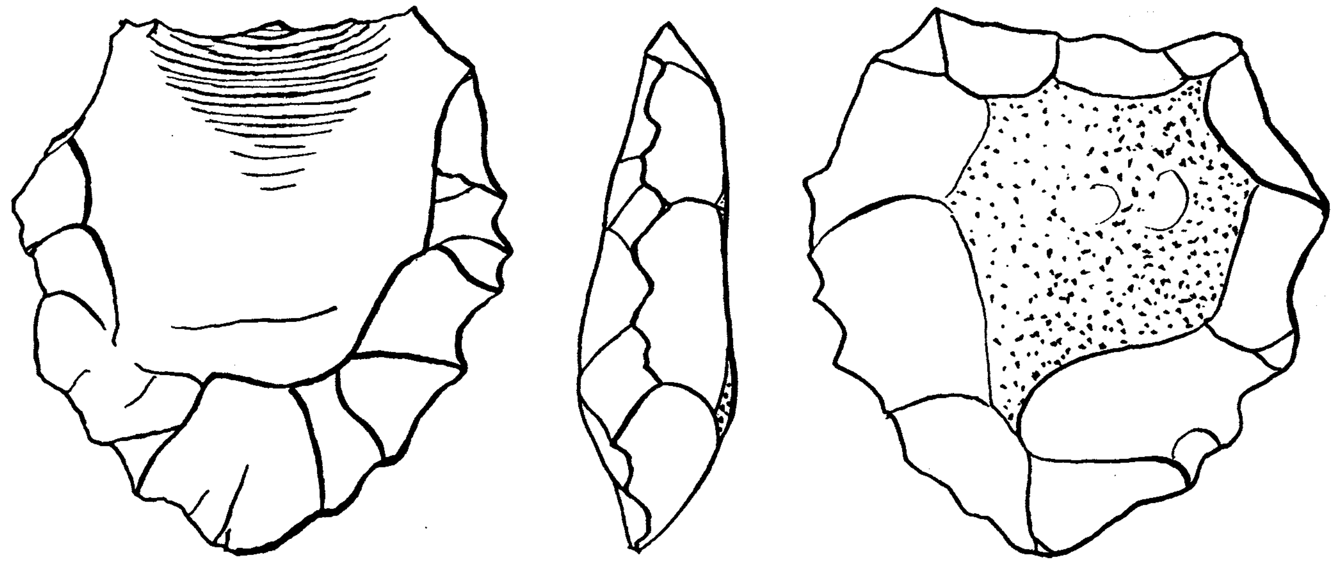


FIG. 15.—MOUSTERIAN CORE FROM GRAVELS OF THE 25-FOOT NILE TERRACE AT HAMMAM MONASTERY, NEAR THE LAHUN PYRAMID NATURAL SIZE.

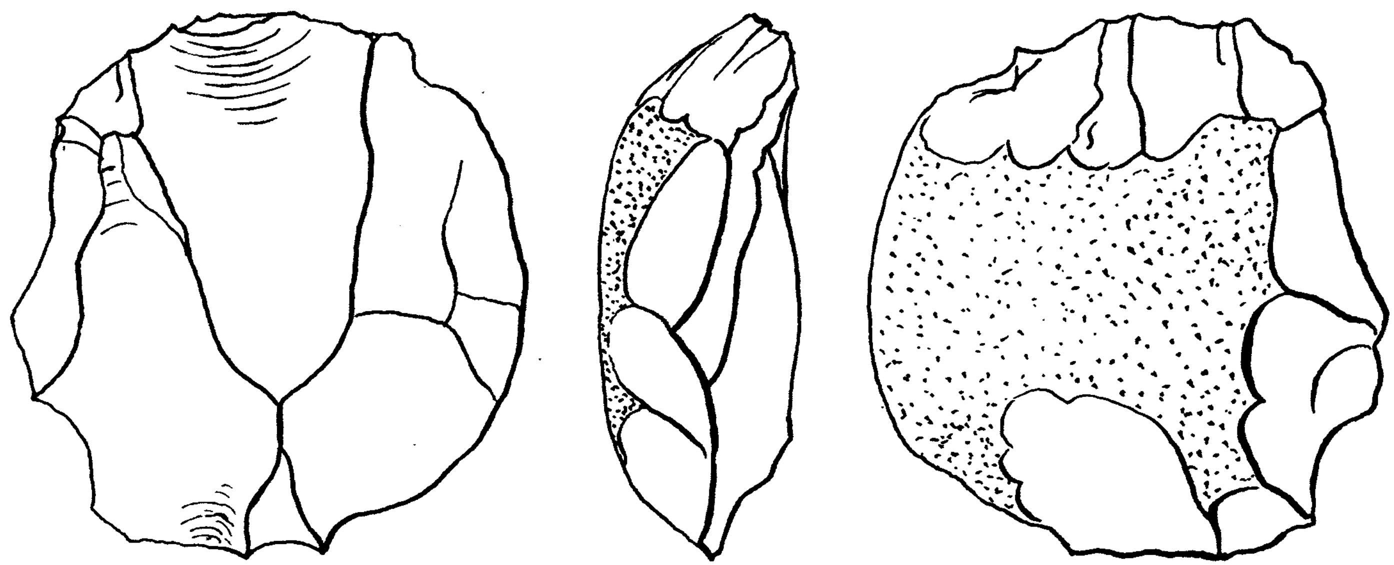


FIG. 16.—MOUSTERIAN CORE FROM THE 112-FOOT BEACH NEAR ḲASR BASIL (TUTUN). NATURAL SIZE

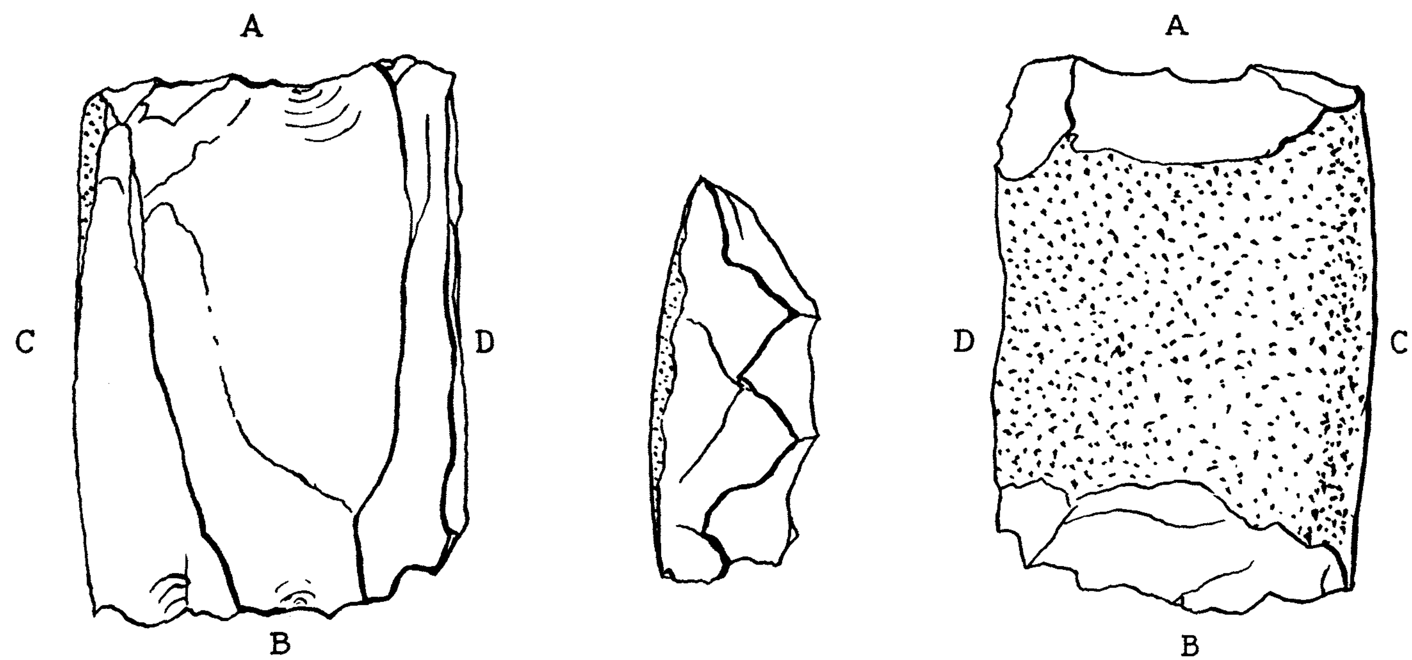


FIG. 17.—MOUSTERIAN CORE FROM THE BEACH OF THE 112-FOOT LAKE, ḲASR BASIL (TUTUN). NATURAL SIZE

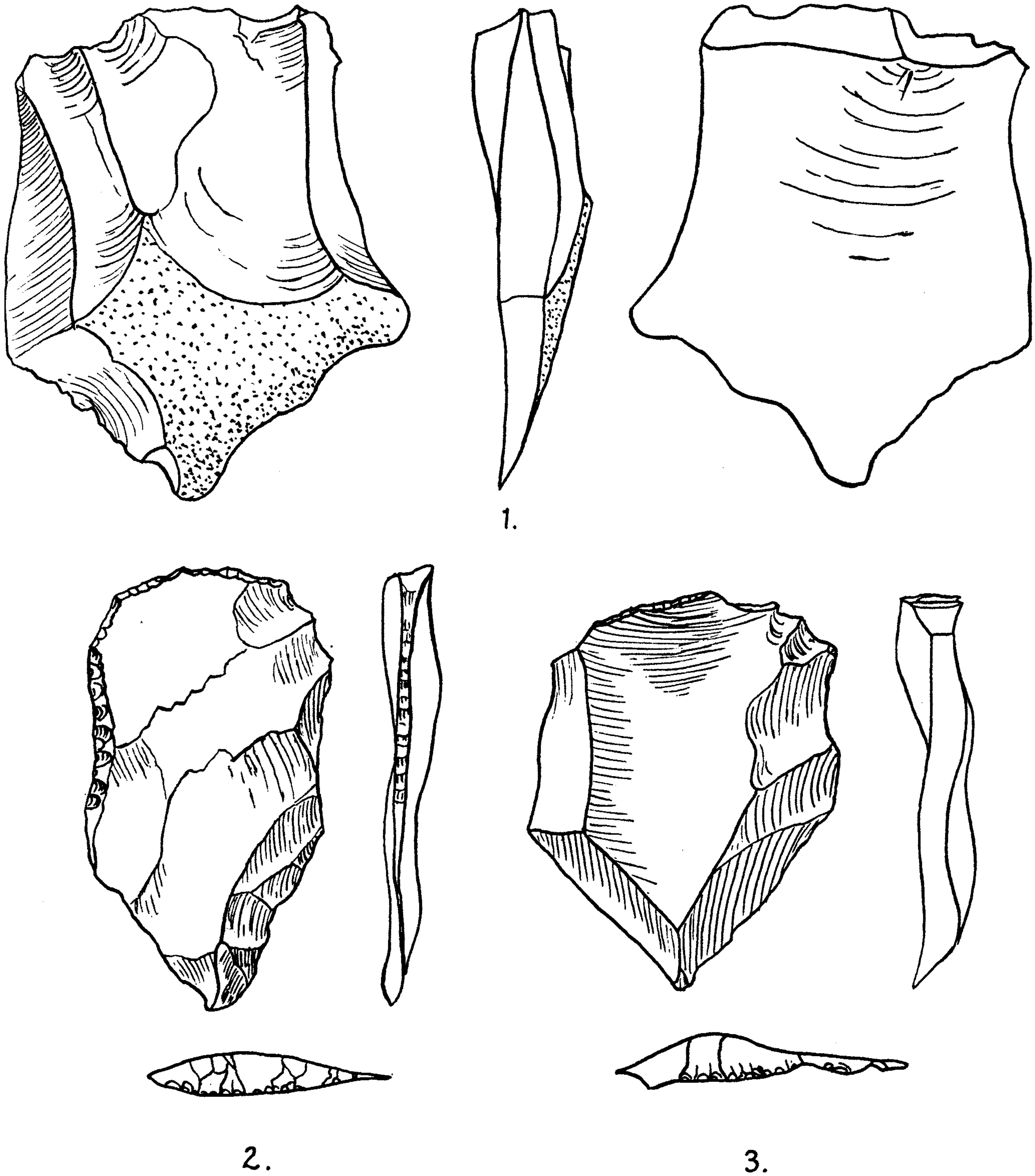


Fig. 18.—Mousterian Flakes from Beaches and River Gravels: No. 1 from 112-Foot Beach, Ḳasr Basil (Tutun); No. 2 from Dimishḳin; No. 3 from 25-Foot Nile Terrace, Kom Tima. Natural Size.

Such are the outstanding characters of the Mousterian industry as we have found it *in situ* in the beaches of the Faiyum and in the contemporary gravels of the Hawara Channel and adjacent parts of the Nile Valley.

With these types are less stereotyped forms, produced, for example, by the removal of a flake from a shapeless lump of flint, or by the secondary flaking of both surfaces and edges of a large flake to produce the beautiful implements of Figure 19 (probably from large cores of the type of Fig. 12). With these and with the wider aspect of the industry we do not propose to deal at this stage of our general survey.

THE LATE PALEOLITHIC STAGE

The key to events which follow mid-Paleolithic times is to be found in Upper Egypt, where desiccation now became a serious factor in human affairs. Even the greater tributaries of the Nile seem to have dried up, and we find no evidence of Man wandering far afield as of old. He was forced to concentrate by the river's banks and swamps and to abandon his hunting life for a more settled existence. In his kitchen middens shellfish abound, with bones of fish, of animals that came to the water to drink, and of hippopotamus. The Nile was at last the great river flowing from the remote south, well watered as now, into a region becoming desolate.

We are indebted to M. E. Vignard for a description of the implements which are found in the kitchen middens and in the silts associated with them. His work is based on the results of considerable excavations which he made in the silts of the Kom Ombo plain, between Edfu and Assuan.[1]

As we understand them, his conclusions (so far as they concern us in the present paper) may be briefly stated as follows: (1) The Mousterian industry was not superseded by the introduction of a foreign technique, but evolved locally without external influence. The change can be traced through the implements of the lower deposits. (2) In time, the industry ceased to be Mousterian, or to be recognizable as such, owing to profound modification and growth of new types. M. Vignard calls this changing indigenous industry the Sebilian. (3) He traces its development and divides it into three layers: Sebilian I, II, and III. The last includes microlithic flakes and implements of geometric design. (4) Sebilian III may be comparable in both age and technique with the Tardenoisian industry.

But the Tardenoisian is generally supposed to be a descendant of the Capsian; and Early Capsian is similar to the Aurignacian of Europe, while

[1] E. Vignard, "Une nouvelle industrie lithique, le Sébilien," ***Bulletin de l'Institut français d'Archéologie orientale***, XXII (1923), 1–76, with 2 maps and 24 plates.

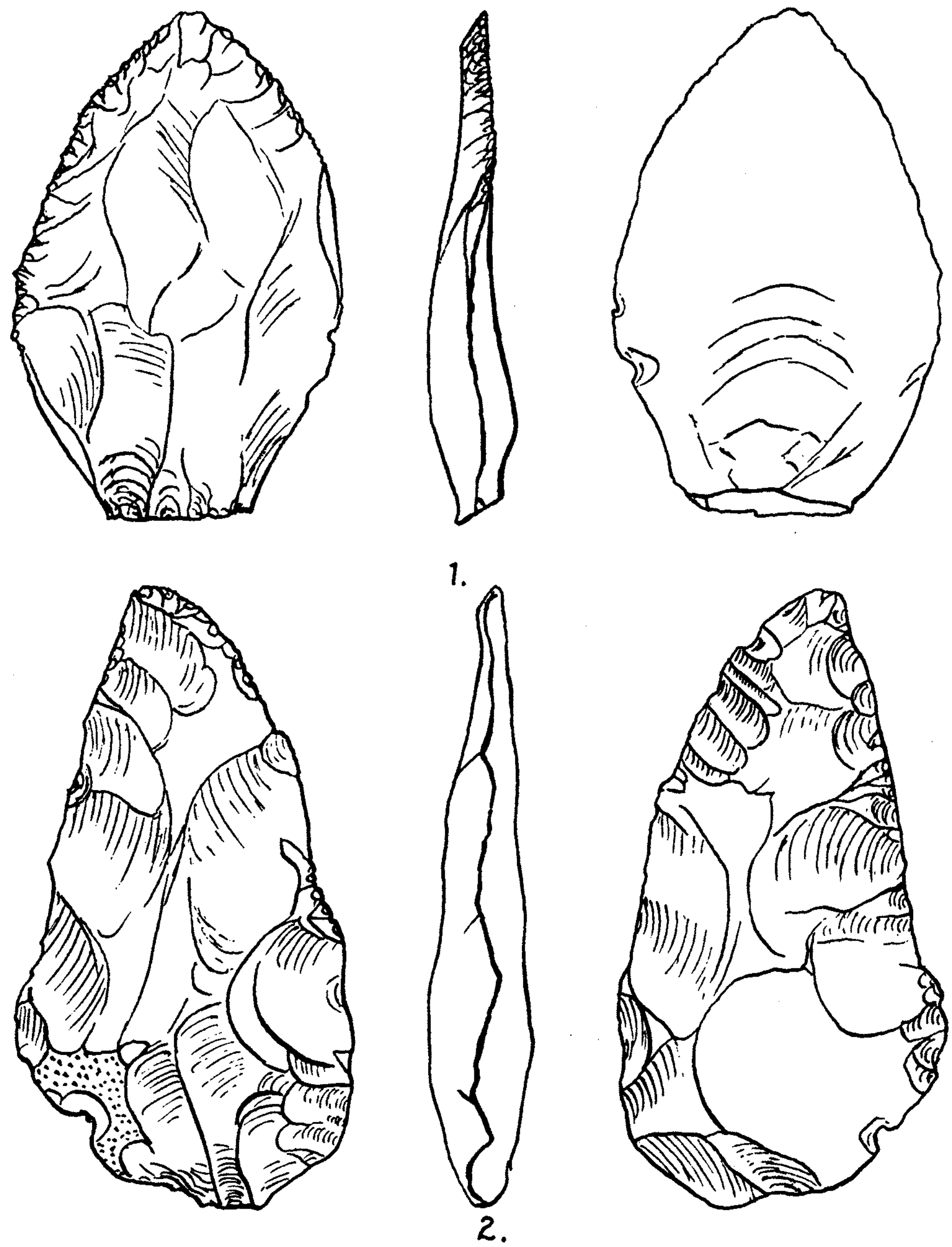


FIG. 19.—RETOUCHED MOUSTERIAN FLAKES FROM THE 112-FOOT BEACH NEAR ḲASR BASIL (1) AND GEBEL ER-RUS (2). NATURAL SIZE.

Late Capsian "represents an evolution independent of the Solutreo-Magdalenian of Europe, but parallel to and synchronous with it."[1]

On the one hand, therefore, we are presented with Mousterian developing *locally* to Tardenoisian; on the other, with a descent to the latter from Aurignacian through Capsian stages in North Africa, Spain, and other parts of the Mediterranean littoral. This implicates us in a discussion of great interest, but one which is beside the purpose of the present paper. So far as we are concerned, certain phases of the Sebilian, whatever the genealogy of that industry (and from field experience in Upper Egypt we support M. Vignard's claim), are contemporary with certain stages of the Capsian.

The Sebilian industry, however, is not confined to the Kom Ombo plain; we have ourselves traced it in silts nearly to Luxor, while M. Vignard reports an Aurignacian industry from Nag' Hamadi.

In Lower Egypt we have now found, *in situ* in the stage which we are about to describe, implements of similar type. As yet we have not explored far enough in Lower Egypt to judge these scanty implements to our satisfaction. Certain of the distinctive types have appeared, but others have not. No geometric forms have been found. For the present, therefore, we apply to this group the term Late Paleolithic, primarily to indicate that it is post-Mousterian (as we shall demonstrate by the lake deposits we have identified in the Faiyum). We know also that it is far removed in time and in culture from the Neolithic. In fact, wholly or in part, it occupies the position of the European Upper Paleolithic industries.

In Lower Egypt, under the influence of the Mediterranean and of the great storms which swept across it and encroached deep into its littoral, desert conditions seem to have been staved off for a longer period than in Upper Egypt. We see from the presence of gravels in the Hawara Channel indications of a local augmentation of the Nile's northerly flow, which brought only silts.

The discovery of the implements which serve to correlate within present working-limits these gravels of Lower Egypt with the silts of Upper Egypt is thus of the greatest importance to the treatment of the Nile basin north of the First Cataract. It fulfils all present requirements and opens the door to a further and more detailed knowledge of Paleolithic Man's cultural advancement.

THE DEPOSITS OF THE LATE PALEOLITHIC STAGE.—This phase is traceable except on the Nileward side.

a) *In the Nile Valley* these deposits have been destroyed or their level coin-

[1] Hugo Obermaier, *Fossil Man in Spain* (New Haven: Yale University Press, 1924), p. 114 (and numerous other pages; see his Index).

cides so nearly with that of the modern alluvium that they have escaped detection.

b) *In the Hawara Channel,* starting at the east side, we meet a local but important occurrence of fine gravel and Nile silt, resting in hollows eroded in the coarse deposits of the Lower Paleolithic river bed. These are best displayed on the west side of the ruins of Kom Medinet Ghurab, in excavated graves associated with that site and in a quarry. The sections vary considerably, but agree in giving about 6 feet of true Nile silt lying on remains of the coarse Lower Paleolithic gravel, capped by a foot or so of fine gravel, and interlaminated with strings and fine seams of pebbles. Most sections show the silt hardened by the universally present travertine, which seems in part at least, and here especially, to be a secondary mineral to the yet commoner gypsum or selenite "flowers." In the quarry, however, the silt is but little consolidated and seems to be in demand for the daily needs of the *fellahin* (bricks, mud-and-wattle, and so on).

The silt and fine gravel contain fresh-water shells, sometimes abundant (in particular, *Corbicula consobrina*), and, more important from our point of view, flint implements of the Sebilian industry, which we have not seen heretofore in Lower Egypt. In one exposure the implements were imbedded in a matrix so hard that we were obliged to use a hammer and chisel to extract them.

On following the banks of the Hawara Channel toward the Faiyum, we soon encounter, on both the north and south sides about Dimishḳin, similar gravels and Nile silt, containing similar shells and implements. On both banks below Dimishḳin they form prominent terraces below the level of the Mousterian gravels, separate and distinct from them and of somewhat finer texture.

So far as the scanty occurrences of deposits of this age near the east end of the Hawara Channel allow of measurement (they occur on the south side only, at Kom Medinet Ghurab), there seems to be little or no fall in their level until Dimishḳin is reached (about 101 feet at both places). From Dimishḳin westward there is a rapid fall of 9 or 10 feet, about double that of Mousterian times (cf. Fig. 10).

In spite of the high rate of fall, Nile silts (i.e., silts containing fine mica flakes brought the length of the Nile's course from Abyssinia, and foreign to the Faiyum basin) are marked features, usually below the gravel surface. Where seen in section, they are even-bedded and evidently deposited from slow-moving water; but seams of pebbles and gravel occurring in them mark occasional changes of condition. It must be remembered that we are dealing with the marginal deposits and not with those of the central parts of the channel, where more rapid currents would have prevailed. The step from these observations to the deduction of flood and non-flood times is but a small one. The silts might have been deposited by waters flowing back from the lake to the Nile in times of flood, but there is no satisfactory evidence on this last point.

c) *Within the Faiyum* the gravel banks flanking the Hawara Channel spread out into a second system of beaches, storm beaches, and shoals, closely resembling those associated with the lake of Mousterian times. A considerable number of levels taken within the depression show that the water in the new lake stood at about 92 feet above sea-level, or 20 feet below its elevation in Mousterian times. The shingle banks piled up along the east shore rise on an average 10 feet above the true beach, indicating a smaller and shallower lake and possibly less violent winds than in Mousterian times (when the storm beaches were commonly piled up to a height of 15 ft. and more). That the new lake was smaller than its predecessor might be anticipated from what we have learned of the climatic changes in Upper Egypt.

Implements generally are rare, being much commoner in the Hawara Channel; but an exceptionally prolific site was found near Philadelphia.

The molluscan fauna is slightly richer in species than that of the Mousterian lake, but no species have been found which are not living at the present day. *Corbicula consobrina* may be said to be the characteristic fossil, but *C. artini* is also plentiful. In addition to these, *Vivipara unicolor*, *Cleopatra bulimoides*, and *Unio gaillardoti* were collected at Philadelphia, and *Aetheria elliptica* near the Hawara pyramid. It is noteworthy that the highly characteristic *Unio willcocksi* Bullen Newton, which is so invariably associated in great abundance with Late Paleolithic flint implements in the silts of Upper Egypt, has not yet been found in Lower Egypt or the Faiyum.[1]

We shall now make a rapid survey from north to south:

a) The beach is a prominent feature in the great bay of Philadelphia, and the greater part of the Greco-Roman town was built upon it and just behind it (Plate VII, *B*). It is broken at the southern headland, but continues across

[1] This extinct *Unio* is so abundant in parts of Upper Egypt that it seems to have been used by the Sebilians as food and has been heaped up to form kitchen middens. It is there confined to the silts containing Sebilian implements, in which we have found it from Luxor to Wadi Halfa. The first specimens were figured by R. Bullen Newton in *Geol. Mag.*, 1899, p. 406 and Plate XX, from Kom Ombo, the types being now preserved in the Geological Survey Museum, Cairo. This paper seems to have been overlooked by Pallary, who in his standard work, *Catalogue de la Faune malacologique d'Égypte*, Suppl. 1924 (in *Mémoires présentés à l'Institut d'Égypte*, Tome VII), Plate IV, 16–18, refigures specimens from the nearby village of Sebil in the Kom Ombo plain under the name *Unio Vignardi* Pallary. Blanckenhorn, throughout his works, wrongly identifies the species with *Unio schweinfurthi* Martens (*Sitz. der Gesell. naturforsch. Freunde zu Berlin*, 1886, p. 127), from Edweh in the Faiyum, with Martens' measurements of which it does not agree. We have now seen topotypes of *U. schweinfurthi* collected by Miss Gardner and can confirm that the two species are quite distinct.

the next indentation to the foot of Gebel er-Rus (Plate VII, *A*). A short distance south of Philadelphia large numbers of flint implements were found, imbedded in sand of coarse spherical grains, loosely cemented into sandrock below, passing upward toward the water line into coarse shingle. In two days we collected over eighty cores, a few disks, and rare flakes, but all without exception were waterworn (Fig. 22 and Fig. 23, Nos. 1–3).

b) We meet with the beach again on the south side of Gebel er-Rus, from the summit of which its great length and uniformity are best observed (Plate VI, *B*). It continues in an unbroken line as far as the Hawara Channel, where it gives rise to offshore banks and shoals. The storm beach is here a marked feature. In exposures near the Hawara pyramid a few fresh flakes were collected *in situ* (Fig. 23, Nos. 4–7).

c) After leaving the south side of the channel the beach disappears for a space, to reappear in a ridge about 3 miles long on the east of Ḳalamsha.

d) It is broken for about a mile near Shaḳluf Bridge; but we see it again near Ḳasr Basil, whence it runs westward as a boldly defined storm beach until it is lost in the sea of gravel ridges beyond Tebtunis.

Levels.—The following are typical:

	Beach (In Feet above Sea-Level)	Storm Beach
Near the railway	....	100
Bay south of Gebel er-Rus	92	.....
Ezbet Hanna Salih	....	104.9
Philadelphia implement site	93.2	.....
1 mile north of Philadelphia	91.1	.....
Near the beginning of the Edweh Bank	....	103.2
South of Ḳalamsha	....	100.9
Hawara pyramid	....	100.3
Shaḳluf Bridge	....	101.3
Tebtunis	91.9	.....

Younger lakes.—We have already noted that the deposits of the previous stage are hidden or destroyed in the Nile Valley between Bahsamun and Saḳḳara, and that they occur only a few feet above the modern alluvium in the Hawara Channel. The stage which we shall now consider is hidden from view, not only in the Nile Valley and the Hawara Channel, but in that part of the Faiyum adjacent to the channel. Here alluvial material had been continuously discharged since Mousterian times, building up a great fan or delta to which fresh detritus was now added. The process has continued to the present day, though under control during a considerable part of Egyptian history, until the fan stands high above the level of the rest of the cultivated land in the Faiyum.

In particular, it stands higher than the lesser amount of alluvium which has reached the southeast and northeast corners of the depression, where beds are revealed which it has not overlapped and concealed.

In these lower-lying localities a beach is seen which we shall investigate; but we must first describe one of the most remarkable features to be seen within the basin.

In an obscure corner between Shaḳluf Bridge and Ḳasr Basil, in an area scarcely a hundred yards square, are no less than ten beaches, marking a succession of brief halts in a falling lake (Fig. 20 and Plate VIII). Each is com-

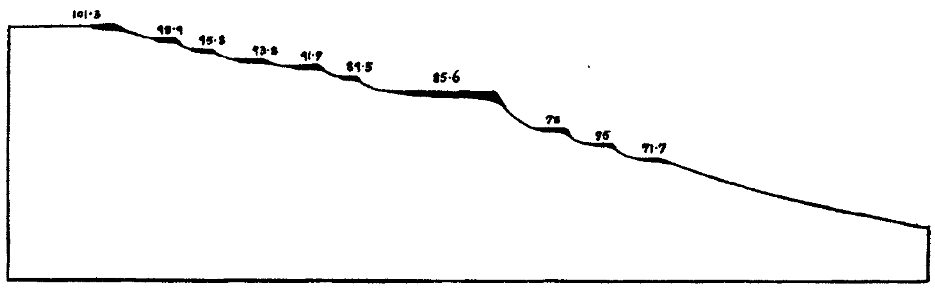


FIG. 20.—SERIES OF BEACHES SHOWING FALLING LAKE-LEVEL, SHAḲLUF BRIDGE, BETWEEN ḲASR BASIL AND ḲALAMSHA. HEIGHTS ARE IN FEET ABOVE SEA-LEVEL. VERTICAL SCALE IS TWICE THE HORIZONTAL.

posed of large and well-rounded chert pebbles (derived locally from the Pliocene gravels), with a narrow sandy strand in front. On one side of the group is a backwater, connected with them and filled with black sandy alluvium.

The beaches serve to connect the lake which we have just described (p. 56) with higher and lower stages, their levels being as follows:

BEACH	FEET ABOVE SEA-LEVEL
1	101.3
2	98.9
3	95.8
4	93.8
5	91.7
6	89.5
7	85.6
8	78.0
9	75.0
10	71.7

Each platform is about 10 feet wide and falls steeply at its outer margin to the next. Beach 7, however, is 43 feet wide (see Fig. 20).

It will be noted that the highest beach is only a little below the Mousterian level (112 ft.) and that the group passes through the 92-foot stage, with four beaches between 95.8 and 89.5 feet. We refer to the lower levels in the paragraphs below. Since we know of no other place in the Faiyum where evidence of intermediate stadia between the more important beaches is preserved, the site is of considerable importance. Unfortunately, implements and fauna (other than a rolled tortoise core and shells) are absent.

The 74-foot Beach.—In the southeast corner of the Faiyum a cobble bank of low level is first seen below the Mousterian beach near the monastery north of Ḳalamsha and is particularly well developed near the cemetery. When followed southward from Shaḳluf Bridge, it rises higher above the falling surface of the alluvium. It is a clearly delimited feature in the desert between Ḳasr Basil and Tebtunis, and a well-marked hollow is present between its highest part and the rising desert surface behind it. Beyond Tebtunis, in common with the higher beaches, it breaks up into low mounds and rolling gravel plain.

There is a strong suspicion that in this district the beach does not indicate true lake-level of the time, but that it is a storm beach. Representative levels of its top are:

	Feet above Sea-Level
Near Shaḳluf Bridge	80.4
South of Ḳalamsha	78.8
Near Tebtunis	82.2

On the north side of the Hawara Channel we notice the beachlike ridge which, projecting from the desert near Edweh, stands above the alluvium about as far as Medinet el-Faiyum (see map), while detached portions have been traced beyond the town (not marked on map). This is the Edweh Bank. As seen near that town, it consists of shingle, with consolidated sand dunes on the Hawara Channel side. Its level, where we measured it, is 81.6 feet above sea-level. At its eastern end it joins the desert edge and continues northward. Then, after a gap of a few miles, it reappears in a cobble beach on the edge of the desert below the scarp of Gebel er-Rus (see map). Thence we follow it into the desert toward Philadelphia.

Immediately northwest of the ruins the beach attains magnificent proportions, and any doubt that may have been entertained as to its true nature is dispelled (Plate IX). We find a high beach of large cobbles and loose shingle, with a deep hollow on its landward side. On the lake side also it descends sharply, and beyond doubt it is a splendidly preserved storm beach. At no other place in the Faiyum have we seen so well marked a storm bank, composed of such coarse material; it is almost impossible to believe that the beach has not been quite recently piled up by the waves of the lake. But the Birket Ḳarun now lies some 230 feet below it.

Rills which dissect the storm beach reveal that its thickness is about 10 feet, the pebbles being piled upon the surface of older deposits which slope in front of it fairly gently toward the modern alluvium. The level of the top is 81.7 feet and of the base approximately 72 feet. On the eastern side of the basin the base of the beach is not visible above alluvium at any other point, and its level here (72 ft.) is not entirely satisfactory. We have no hesitation in adopting the level of 74 feet obtained by Miss E. W. Gardner after much careful work on the north side of the basin. At this point, therefore, we effect a junction with the admirable work which this lady has so laboriously carried out.

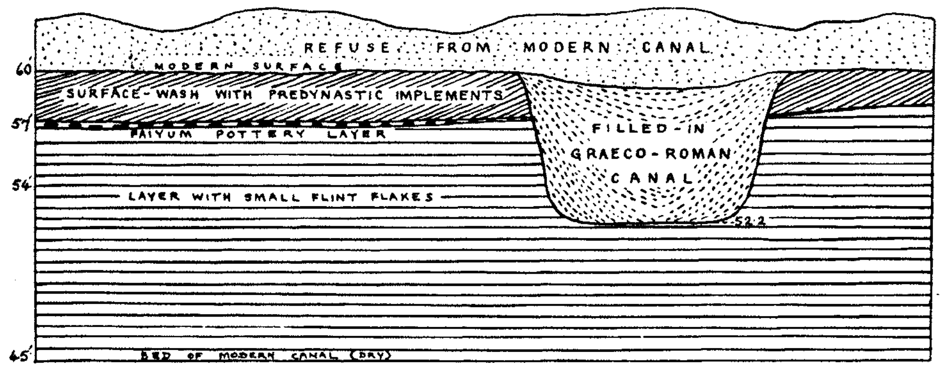


FIG. 21.—SECTION IN DRY CANAL NEAR EZBET GEORGE

With regard to the exact age of the 74-foot lake, we can add little direct evidence from implements to the observations of Miss Caton-Thompson and Miss Gardner, who found it entirely barren of implements on the north side, but regarded it as Mousterian in age. We have now been able to show that it is later than the 92-foot lake, which itself contains small Late Paleolithic implements; but until the whole of the typology has been worked out we do not venture an opinion on the exact position of these with relation to the Paleolithic sequence of Europe.

Most of the microlithic types of the Sebilian of Upper Egypt still remain to be discovered in Lower Egypt. In only two places in the Faiyum did we find flakes which, though crude and unsatisfactory, were yet considerably smaller than those of the 92-foot lake period and might possibly be considered to represent the culmination of Paleolithic industries in Lower Egypt.[1] In only one of these occurrences were the flakes *in situ* in a lake deposit, and that was near

[1] Cf. p. 66, n. 1.

Ezbet George, a short distance to the east of Umm el-Atl (Fig. 21). Here a few such flakes (Fig. 25, Nos. 1–3) were imbedded firmly in a fine gravelly and silty deposit at 54 feet above sea-level, exposed in the side of a dry canal. The site is close to the edge of modern cultivation, and the level of the deposits in which the flakes occurred indicates that they belong to the 74-foot lake. They are sealed above by some 6 inches of silt with fragments of "Faiyum" (Neolithic) pottery at 57 feet above sea-level, apparently the actual shore deposit of the Neolithic lake; and above all is a thick surface wash containing crude flints of predynastic type. We include a diagram of this section because the evidence, although unsatisfactory, is as yet all we have in the Faiyum.

A number of small flakes (Fig. 25, Nos. 4 and 5) were found in a surface wash overlying and in part cut into the Mousterian deposits at Ḳasr Basil near Tutun (see Fig. 11, the dotted line). Here they were associated with burnt flint and fragments of bone. At first sight the occurrence might be mistaken for a beach deposit; but our opinion that it is a surface wash deposited in a vanished streamlet or runnel was confirmed by tracing it high up a small valley behind, where another flake was found *in situ*.

Notes on the Late Paleolithic implements.—The use of the term "Late Paleolithic" has already been explained (cf. pp. 52–54), and in the notes on the Mousterian implements (pp. 45–52) we have already stated our reasons for leaving a comprehensive typological study until a later date.

The industry of the 92-foot beach and of the associated gravels of the Hawara Channel is of surprising uniformity. Although we have found it *in situ* in a number of places, and particularly near Philadelphia, we have found only (*a*) a multitude of almost identical cores, (*b*) a few flakes, and (*c*) rare examples of another type of core.

a) The cores are miniatures of the Mousterian double-ended core. They are made in the same way from pebbles, but their longest side seldom exceeds an inch and a half in length. They are more frequently square and more regular than the Mousterian core of Figure 17, and, in all but exceptional specimens, flakes have been removed from opposite ends on the same face, the other side usually being left as untrimmed cortex (Fig. 22).

They are clearly the immediate successors of the Mousterian core shown in Figure 17, but we have never seen them mixed. On typological as well as geological grounds we see they are of later and distinct age, and in the interval the design had become standardized. Thus near Philadelphia they were clearly produced "on repetition lines" by the score. Further evidence of the time interval between these and the Mousterian industry was provided in Upper Egypt, where we found similar cores in the silts which cover the Mousterian

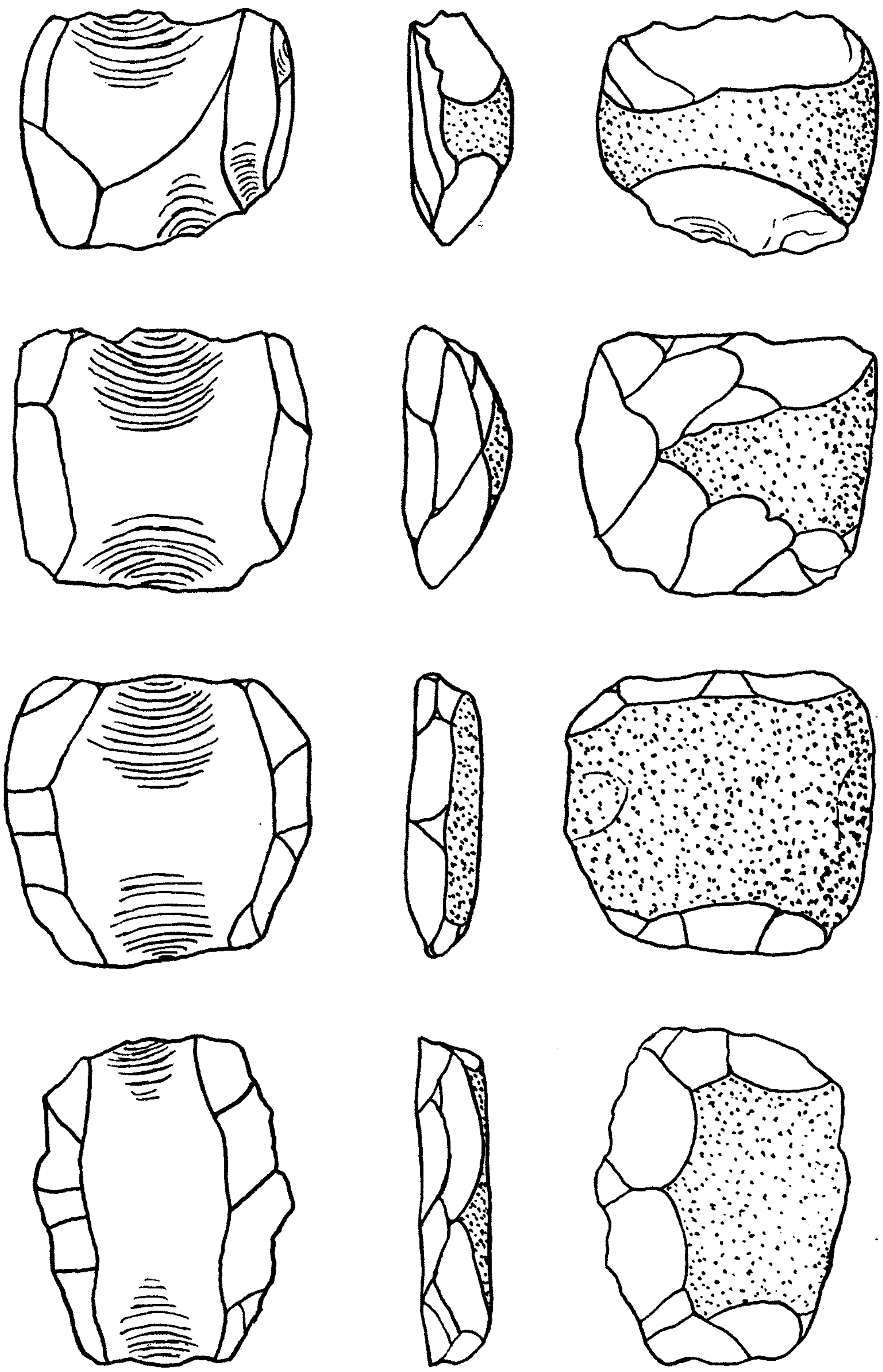


Fig. 22.—Late Paleolithic (Sebilian) Double-ended Cores from the 92-Foot Beach near Philadelphia. Natural Size.

gravels between Assuan and Luxor. Somewhat similar cores are also figured by Vignard[1] from his Sebilian II levels, and we have applied the term Sebilian to them. This, at the moment, is largely a matter of convenience; but it signifies none the less their Mousterian line of descent and post–Middle Paleolithic age. On geological grounds also we refer them definitely to post-Mousterian times.

b) The flakes fall into two classes. The first type is a miniature of the Mousterian flake, from cores such as are shown in Figures 12–14, and is, in effect, a point (Fig. 23, Nos. 5–7). In the second the Mousterian plan is abandoned, and a thin but broad flake, with straight parallel sides, takes its place (Fig. 23, Nos. 1–4); a point does not seem to have been the object intended. The lower side of each flake is a plain surface bearing the bulb; the upper shows a number of long and sometimes irregular flake-scars, the surface obtained in removing the cortex of the pebble.

A part of the prepared striking-platform is usually (but not always) carried away on the flake, which accordingly may show minute facets. The bulb of percussion in some specimens is large for the size of the flake it governs.

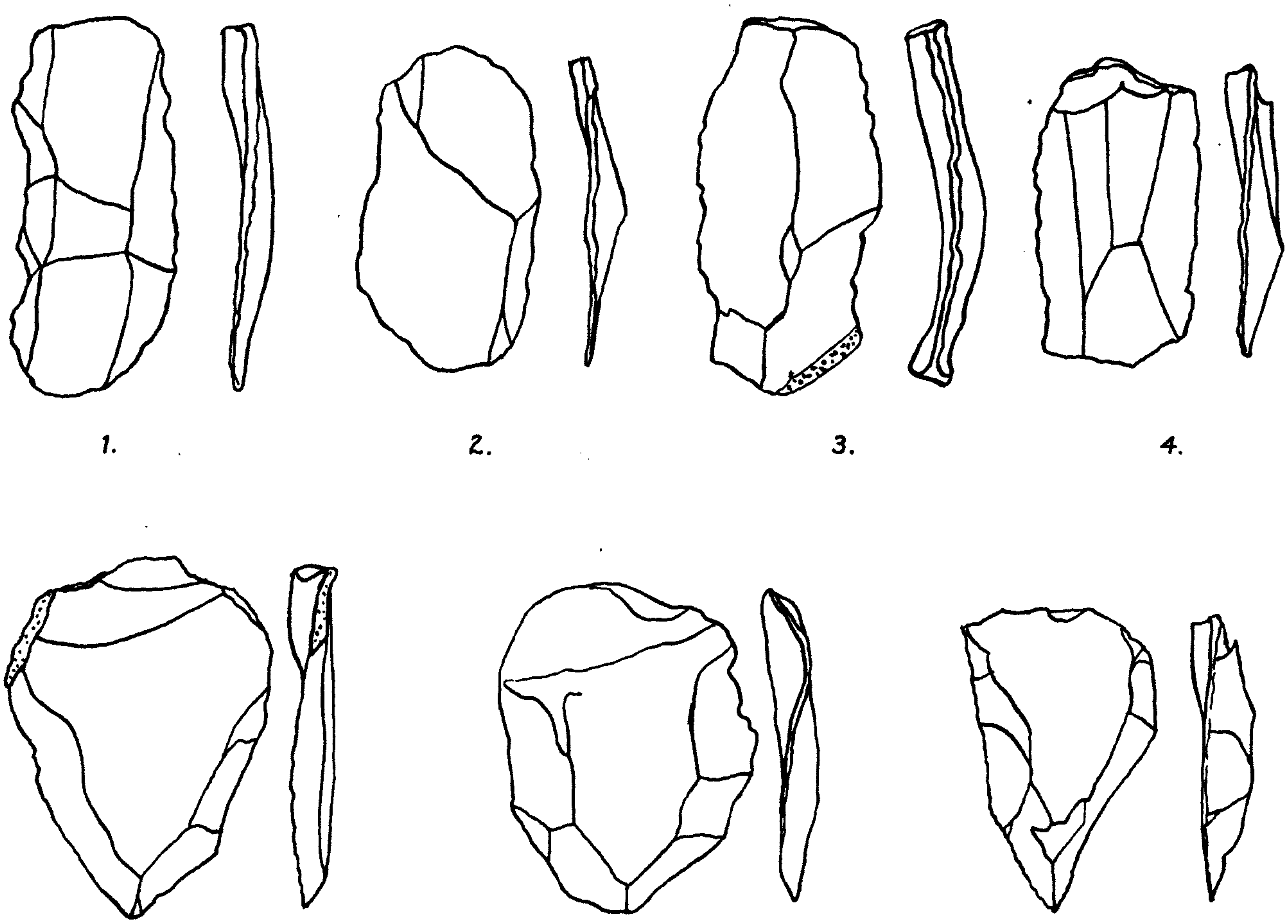
Though only a limited number of flakes were found, they may be compared (as might be supposed) with those of the Lower and Middle Sebilian levels of Vignard.

Flakes and cores were evidently made for some special and important purpose. As the people were living by the waterside here and in the Kom Ombo plain and in general between Assuan and Luxor, it is natural to assume that the tools had some essential bearing upon their makers' mode of existence, in which hunting now probably played a secondary part.

c) Perhaps most significant of all are rare cores which are in condition identical with that of the other two types of implement (e.g., at Philadelphia). They are rolled, as are the others, and much decomposed. They were found *in situ* side by side with the other types and evidently are of much the same age. They seem to mark the development of the double-ended core into a cylinder, elongated pebbles being chosen and the cortex removed in narrow strips by flaking from either end. Thereafter long and extremely thin and delicate flakes were removed by a similar process (Fig. 24 and Fig. 25, Nos. 4 and 5). We have, in fact, arrived at an essentially "late" type of core which, with modifications, lingered on in Egypt until the dawn of dynastic times.

Of the few flakes from Ezbet George and Ḳasr Basil (Tutun) we may note the considerable diminution in size in comparison with the flakes from the 92-

[1] *Op. cit.*, Pl. VI, 1–3.



1. 2. 3. 4.

5. 6. 7.

FIG. 23.—LATE PALEOLITHIC (SEBILIAN) FLAKES FROM THE 92-FOOT BEACH: NOS. 1–3 FOUND NEAR PHILADELPHIA; NOS. 4–7 FOUND NEAR DIMISHḲIN. NATURAL SIZE.

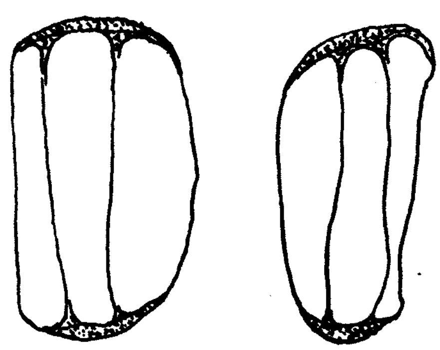


FIG. 24. CORE OF LATE PALEOLITHIC (SEBILIAN) AGE, FROM THE 92-FOOT BEACH NEAR PHILADELPHIA. NATURAL SIZE.

toot beach system. With this reduction we see more delicate work, minute flaking, and slender proportions (Fig. 25). We cannot refer these to any special part of the Sebilian series, though we assign them to that industry and, on geological and typological grounds, to a fairly late phase of it. The larger flake figured from Tutun recalls predynastic work, but we have found this type in the Sebilian silts of Upper Egypt.

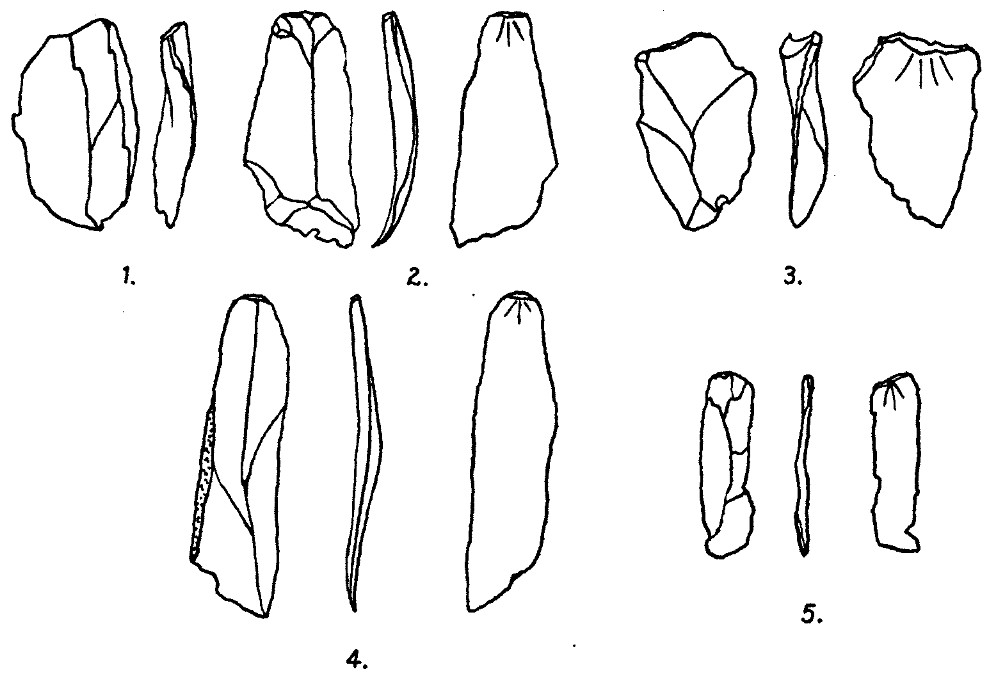


Fig. 25.—Nos. 1–3, the Small Flakes Deposited at the 54-Foot Level by the 74-Foot Lake at Ezbet George as Shown in Fig. 21; Nos. 4–5 from Ancient Surface Wash Resting upon 112-Foot Lake Deposits at Ḳasr Basil (Tutun) as Shown in Fig. 11. Natural Size.

Reviewing the collection as a whole, one is struck by its monotony. Retouched flakes or cores, burins, scrapers, and other types which we might expect, fail to appear. The uppermost Sebilian forms are entirely lacking, e.g., those which approach Tardenoisian or even Late Capsian technique. With the exception of the cylindrical core from Philadelphia, a type which does not appear in M. Vignard's plates, and the flakes from Tutun and Ezbet George, we have found in these beach systems no implement comparable with the last division of the Sebilian; only the first and second seem represented. We are, therefore, of the opinion that a considerable part of the history of the interval from the time of the 92-foot lake to that of the 57-foot (Neolithic) lake was contemporary with a Late Paleolithic industry in Egypt.[1]

At the older extreme, we recognize such close affinities between certain of the implements of the 112-foot (Mousterian) beach system and of the 92-foot system that we refer the former to *late* Mousterian times with the remark that the break between the two is geological rather than typological.

THE TRANSITION TO NEOLITHIC TIMES, AND CONCLUSION

Our field work virtually comes to an end with the 74-foot beach, but we may conclude this discussion by bringing it down to Neolithic times and incorporating certain observations and deductions.

In the foregoing sections we have traced the vicissitudes of a great lake which came into being at least as early as Mousterian times and contracted through the Middle and Late Paleolithic stages. We have noted three marked pauses in that contraction and have seen them linked together in a single descending series of ten beaches. Below the lowest we reach the alluvium, which conceals all further evidence in the eastern Faiyum; but, once we are away from the great alluvial fan, lower lake stages are revealed. This has made possible the observations of Miss Caton-Thompson and Miss Gardner, to whose work we shall now refer.

In the first careful work on the Faiyum lake deposits[2] and in their more recent paper,[3] these ladies may be said to have established the following facts: (1) That the 74-foot lake was succeeded by another lake at 57 feet above sea-level. (2) That the age of the 57-foot lake is Neolithic, the settlements of the "Faiyum" (i.e., Neolithic) people being grouped along its shore. (3) That the

[1] After this paper was ready for the press, Professor Hermann Junker published the results of the 1927–28 expedition of the Vienna Academy in the western Delta (*Denkschr. Ak. Wiss. in Wien, Phil.-hist. Kl.*, Band LXVIII [1928], 3. Abh.). Professor Junker found microliths at Abu Galib and elsewhere, of which the figured specimens appear to be identical with those found by us at Ḳasr Basil and Ezbet George. On typological evidence—since the implements were found on the surface—Professor Junker attributes an Upper Capsian *age* to his discoveries, and looks upon them as of Upper Sebilian *type*.

It is a fortunate circumstance that we can show on *stratigraphical* evidence that the implements are Middle Sebilian or younger, and pre-Neolithic. This is established without reference to typological form, in which we see little affinity with either Upper Sebilian or Capsian industries.

Thus the implements of the two sites in the Faiyum are shown to be of more than local importance. With those of Abu Galib they serve to add another page to the still fragmentary history of pre-Neolithic culture.

In a footnote we cannot discuss the wider aspects of Professor Junker's valuable treatise.

[2] G. Caton-Thompson and E. W. Gardner, "The Recent Geology and Neolithic Industry of the Northern Fayum Desert," *Jour. Roy. Anthrop. Inst.*, LVI (1926), 301–23; E. W. Gardner, "The Recent Geology of the Northern Fayum Desert," *Geol. Mag.*, LXIV (1927), 386–410.

[3] "Recent Work on the Problem of Lake Moeris," *Geographical Journal*, LXXIII (1929), 20–60.

74-foot and Neolithic lakes were separated by a long interval of time, during which the basin was drained and the old lake deposits were deeply eroded before the water rose again to the 57-foot level. (4) That the water-level then again sank in stages from the 57-foot level, decadent Neolithic industries being associated with it down to 7 feet below sea-level. (5) That it has since continued to sink until the present day, when its surface lies at 147 feet below sea-level and only 18 feet above the bottom in the deepest part. (6) That the last stage of contraction has been accompanied by a sudden increase in salinity, which has killed most of the fresh-water fauna, two marine bivalves taking its place.

Of these conclusions, all of interest to the archaeologist, the one which principally concerns us here is No. 3. The period of erosion proved by Miss Gardner to have supervened between the periods of the 74-foot and 57-foot lakes is also referred to by the same authors as a period of "desiccation." The two appellations seem to us to be contradictory. The type of erosion proved and its extent seem quite clearly to indicate water as its agency.

The bottom deposits and coarse littoral sediments of the 74-foot lake were so deeply eroded by Neolithic times that in many places only scattered hummocks remained. Round the foot of these hummocks were situated the habitation sites of the Neolithic people.[1] Aeolian denudation during the post-Neolithic desert period, therefore, has not only left the implements where they had fallen, but has failed appreciably to reduce the size of the hummocks. It is inconceivable that the original reduction of the deposits to these remnants can have been effected by similar aeolian erosion between the 74-foot lake and Neolithic times, an interval of no great duration for the magnitude of the erosion accomplished.

But if the local rainfall was sufficiently heavy to erode the deposits of the 74-foot lake into widely separated hummocks, why did the lake temporarily disappear? Further, whither was the 40-foot layer of débris, too coarse to be blown away,[2] transported? The correct explanation seems to be that the old connection with the Nile, which we have traced from Mousterian times and have reason to suppose was established much earlier, was never severed, but now continued *with a reversal of drainage.*

We observed in the Introduction that a rock barrier across the Hawara Channel has never been proved, and that the evidence points to that channel, although narrow, being exceedingly deep. Confirmation could only be obtained by a series of deep borings; but in the Nile Valley many deep borings

[1] Caton-Thompson and Gardner, *Jour. Roy. Anthrop. Inst.*, LVI (1926), Plate XXXIV.

[2] Gardner, *op. cit.*, p. 392.

have already been sunk, and the rock bottom of the valley in Lower Egypt has never yet been reached. We know (1) that the Nile has cut this deep channel since Mousterian times and (2) that it is still recovering its level by annual increments to the alluvium, at a rate which has been measured by archaeologists.

From a consideration of these facts we believe that the fall of the Faiyum lake from 74 feet, as from previous levels, was due to falls in the level of the Nile, which supplied it with water. We have seen at Shaḳluf Bridge (Plate VIII and Fig. 20) relics of beaches formed during many successive drops, which prove that the process was gradual. The last beach seen there is at 71.7 feet. The Nile continued to degrade its bed until it reached and passed the low level which we have reason to believe it had attained immediately before Mousterian or in early Mousterian times (cf. pp. 36–37). From that moment the Faiyum became a tributary once more, the lake disappeared, and the rain falling on the old bottom deposits eroded them as described by Miss Gardner and carried the débris through the Hawara Channel into the Nile. The lowering of the channel and of the Faiyum behind thus kept pace with the lowering of the main river. In support of this we notice the fact that the lowest part of the Faiyum now visible has the structure of an ordinary wadi cut in inclined strata; it shows, in fact, the characters known to geologists as those of a "strike stream" in its upper reaches below the cliffs of Ḳasr es-Sagha (cf. Fig. 1).

Then came the turning-point, and the lower Nile began to aggrade its bed once more—the beginning of the upward movement which is still slowly continuing. Silts began to fill up the valley and to pour into the Hawara Channel. Within the Faiyum the water was ponded back once more into a lake, fed as before by the Nile, while the incoming silts began to build up the great fan-shaped delta which now forms such a conspicuous feature of the eastern part of the basin. Nile and lake rose together until the lake reached the 57-foot level, when it paused.

Meanwhile, desert conditions, which had already become severe in Upper Egypt, had spread northward and the supply of local rainfall was so reduced that (1) the headwaters of the deepened Faiyum tributary were not filling up with the products of local erosion as fast as the eastern end was becoming choked with Nile silt, and so have remained the deepest part to this day; (2) evaporation was beginning to counteract the inflow of the Nile, which itself became greatly reduced in volume, bringing proportionately less water into the Faiyum.

The pause at 57 feet seems to have resulted from a temporary equilibrium between evaporation and inflow from the Nile. But evaporation eventually prevailed, as desert conditions became more rigorous; and the level of the lake has continued to fall until the present day, although the Nile is still aggrading its bed. The last stages in the fall have been greatly accelerated by Man, who in dynastic times controlled the dwindling supply flowing in from the Nile and allowed it to be far outbalanced by evaporation, thus exposing a fertile lake bed for cultivation.

At the present day enough is left of the Birket Ḳarun (Plate XI) to aid the imagination to picture the majestic sheet of water from which it is derived, the history of which, as witnessed by Paleolithic Man, we have now endeavored to trace.

VI

SUMMARY

The Nile and its tributaries show distinct traces of two cycles of cutting-down. First in Miocene (and perhaps in late Oligocene) times the tableland of Eocene sediments was raised to an unknown height, with the result that the Oligocene river or Ur-Nil, which joined the sea about the latitude of the Faiyum, carved a gorge through which the Nile still flows. South of Cairo there seem to be no deposits dating from the time of this first excavation of the valley, and the history of the period is written only in terms of erosion and earth sculpture. Huge landslips along the sides of the valley remain to show how it was widened, and these have been erroneously held by some to be evidence of a rift origin.

In Pliocene times the land sank or the sea rose, so that the valley became a long gulf, filled by an arm of the Mediterranean. In Lower Egypt we have found highly fossiliferous Middle Pliocene marine sediments up to a height of 100 meters above sea-level, and have traced them upward into estuarine and fluvial gravels to much greater heights. We believe the sea to have stood at least 170 meters above its present level. In Upper Egypt no marine fossils have been found south of Assiut, the presumption being that in the upper reaches of the gulf the water was fresh. The deposits here flank the sides of the Miocene valley up to a height of about 170 meters above the modern sea-level. The head of the gulf has been found near Esneh.

We have been able to reconstruct the natural drainage of Pliocene times, showing that the Faiyum depression as such was not then in existence, but that the region formed part of the Libyan Plateau and drained normally into the Nile.

No evidence of any kind has been obtained favorable to the hypothesis of the existence of Pliocene Man in Egypt.

The fall of the sea from its Pliocene level was accompanied by the re-excavation of the Nile river-system, in the course of which was cut a series of terraces bearing alien gravel brought down from the Red Sea Hills. In the Faiyum and Saḳḳara region we have mapped terraces at the following heights above Nile-level:

Feet above Nile		Meters above Nile
470– 440	or	143– 134
395–?365	or	120–?110
320– 265	or	98– 80
210– 180	or	64– 55

The heights of these terraces show a general correspondence with those established by De Lamothe in Algeria. From the work of Depéret it would seem that they cover the Sicilian and Milazzian periods of the Mediterranean (i.e., post–Upper Pliocene to Pleistocene). They have yielded no implements.

In Upper Egypt we have identified a series of four river-terraces containing in their gravels Lower and Middle Paleolithic implements, as follows:

Feet above Nile		Meters above Nile	
100	or	30	(Chellean)
50	or	15	(Acheulean and Micoque)
30	or	9	(early Mousterian)
10	or	3	(Mousterian)

These have been traced over some hundreds of miles on both sides of the Nile and in the adjoining deserts between Assuan and Assiut.

In Lower Egypt, between the Faiyum and Cairo, the series is less complete. So far, a representative of the 100-foot terrace has not been discovered. We found Chellean (waterworn) and Acheulean (fresh) implements in an old Nile channel at about 70–85 feet.

The Mousterian terrace in Lower Egypt, abounding in implements, stands at about 25 feet, and we have traced it through the Hawara Channel into the Faiyum. We have found that it falls some 5 feet through the channel toward the Faiyum, bringing Nile gravel with it, and passes on the inside of the depression into a well-marked beach, also abounding in implements.

It is thus shown that the Faiyum was by Mousterian times occupied by a vast lake, the connection of which with the Nile is now no longer a matter of conjecture or assumption. The water-level of this lake stood at about 112 feet above sea-level. Along its east side an immense storm beach of shingle and rolled *Corbicula* shells was piled up to a maximum height of 131 feet above sea-level, showing the direction and force of the prevalent storm winds.

In Upper Egypt from Assuan to Esneh we have found silts containing Sebilian (post-Mousterian) implements mounting upon the Mousterian and Acheulean terraces to a height of some 60 feet above the modern alluvium. It is clear that the Nile was aggrading its bed in this region in Late Paleolithic times. Between Esneh and Luxor the height of the silt falls until, near Ḳeneh, it is almost coincident with the alluvium.

In Lower Egypt we have mapped along both sides of the Hawara Channel a second terrace of Nile gravel, the level of which approximates to that of alluvium in the adjacent part of the Nile Valley but falls steeply toward the Faiyum. Here it merges into a second system of beaches parallel to and below that of Mousterian age. Implements of older Sebilian aspect are found in the gravels of this stage, and it is evident that the Nile was degrading its bed at this time in Lower Egypt. At the present time the process of aggradation is going on from the sea to the First Cataract and is especially marked in the Delta.

The level of this second lake in the Faiyum stood at about 92 feet above sea-level, and the shingle is piled up to a height of about 10 feet above it, while in the Hawara Channel the fall from the Nile was greater than in Mousterian times.

After a long pause the level of the lake fell a further 18 feet and formed a beach at 74 feet above sea-level, with a shingle beach rising to 85 feet. This stage also we believe to be of Late Paleolithic age, a conclusion which is strengthened by the discovery in the southeast corner of the Faiyum of no less than ten beaches in descending series from the Mousterian level.

Owing to aggradation which is still in progress, all stratigraphical evidence of the transition to Neolithic times is hidden in the Nile Valley, the Hawara Channel, and the eastern parts of the Faiyum; but evidence is forthcoming from the western parts of the depression. Here Miss E. W. Gardner has demonstrated a prolonged period of subaerial denudation between the 74-foot lake and a 57-foot lake which is of Neolithic age. She suggests that the Nile, degrading its deep (now buried) channel, was no longer in contact with the diminishing Faiyum lake, that the latter dried up, and that the erosion took place in a period of desiccation. We are of opinion, however, that the Faiyum and the Nile remained in contact and that the lake drained itself into the low bed of the Nile, i.e., that there was a reversal of the Middle and Late Paleolithic drainage. The subsequent aggradation placed the Nile again in a position to flood the Faiyum, which it did in Neolithic times.

The surviving lake, saline and 147 feet below sea-level, is artificially controlled and acts as a sump and evaporating-basin for the drainage water of the fields.

Desert conditions seem to have been established in Sebilian times in Upper Egypt, and at a later date as we proceed northward. North of the latitude of the Faiyum they may not have become absolute until post-Neolithic times.

APPENDIX

The following table of lake-levels in the Faiyum may be found useful. We have adhered to sea-level as datum, whereas a new datum, A. L. ("Above Lake," i.e., the modern Birket Ḳarun on Dec. 16, 1925, equivalent to 147.19 ft. *below* sea-level), has been adopted by Miss G. Caton-Thompson and Miss E. W. Gardner in their most recent paper.

Feet above Sea-Level	Period	Feet above Lake (A.L.)
(131)	....	278 (This level, emphasized by G. C.-T. and E. W. G., is not a lake-level, but merely the highest point to which lake materials were carried during storms in Mousterian times.)
112	Mousterian	(259) (Not recognized by G. C.-T. and E. W. G.)
92	Sebilian	(239) (Not recognized by G. C.-T. and E. W. G.)
(74) 75	Later Sebilian	222
(57) 59	Neolithic	206
0	(Sea-level)	147
−7	Dynastic	140
—147	Present Birket Ḳarun	0

INDEX

Abbasiyeh, 29
Abu Galib, 66
Abu Roash, 25
Abusir pyramids valley, 21
Abwit, *see* Ibwit
Abyssinia, 55
Acheulean, ix, 28–29, 31–32, 36, 71
Aetheria elliptica, 56
Africa, ix, 7; North, ix, 5, 7–10, 54; Northeastern, vii–x, 5, 8
Algeria, 26, 31, 71
Alps, 5, 9, 40
Anadara diluvii, see Arca diluvii Lamk.
Andrews, Charles William, 7
Arabia, 5, 8
Arca (Anadara) diluvii Lamk., 13
Asia, Western, viii
Asia Minor, viii
Askren, Dr. and Mrs., 4
Assiut, 5, 70–71
Assuan, 52, 63, 71
Assyria, viii
Astian, 13
Aurignacian, 52, 54

Babylonia, viii
Bahr Wirdan, Pl. IX
Bahr Yusef, 19, 32, Pl. IV
Bahsamun, 14, 32, 57
Beadnell, H. J. L., 3, 5–7, 11, 16
Birket Ḳarun, 2–3, 6, 19–20, 60, 69, 73, Pl. XI
Birket Ḳarun series, 5–6, 14
Blanckenhorn, Max Ludwig, 8, 56
Bovier-Lapierre, Paul, vii, 29
Breasted, James Henry, 1
British Museum, 4
Brown, R. Hanbury, 2, 11
Burdigalian, 9

Cairo, vii–viii, 1–2, 7–8, 10, 23, 27, 29, 40, 70–71
Cairo: Collège de la Sainte Famille, vii; Geological Survey Museum, 56
Callista chione, see Meretrix chione (Linné)
Capsian, 52, 54, 65–66
Cardium echinatum Linné, 13
Cardium edule, Pl. XI
Cardium linnei Mayer Eymar, 13
Cardium subsociale Blanckenhorn, 13
Carolia, 11, 15, 17
Caton-Thompson, Gertrude, 3, 38, 60, 66–67, 73
Cerithium spp., 14
Chamelaea gallina, see Venus gallina Linné
Chellean, ix, 28–32, 36, 71
Chlamys scabrella, 12–13
Cleopatra bulimoides, 56
Connolly, Major M., 4
Cooper, C. Forster, 7
Coptic monasteries, 34, 37
Corbicula, 41–42, 44, 71
Corbicula artini, 33, 38, 41, 56, Pl. IV
Corbicula consobrina, 41, 55–56
Corbicula innesi, 41, Pl. IV
Cretaceous, 5

Dahshur, 23–24
Dahshur pyramids, 12, 21, 34, Pl. III
Dahshur pyramids valley, 20–21
Darb Gerzeh, 33
Darb Gerzeh valley, 35
Delta, ix, 5, 8, 23, 26–27, 66, 72
Dentalium sp., 14
Depéret, Charles, 26, 31–32, 37, 71
Dimei, Pl. XI
Dimishḳin, 37, 44, 51, 55, 64
Dosinia lupina (Linné), 13

Edfu, 52
Edweh, 17, 56, 59
Edweh Bank, 57, 59
Egypt: Geological Survey, vii, 11, 44, 56; Service des Antiquités, 1, 4; Survey Department, 4
elasmobranch fish, 14
Elwat Hialla, *see* Ilwet Hialla
Eocene, 11, 13, 15–17, 19–20, 22, 24–25, 33–35, 40–41, 43–44, 70, Pls. II, V, X; Lower, 5, 7, 22; Middle, 5–6, 14; Upper, 6–7, 11, 15, 17, 21–22
Esneh, 70–71
Europe, ix–x, 52, 54, 60; Southern, ix, 5, 9–10; Western, ix
Ezbet George, 60–61, 63, 65–66
Ezbet Hanna Salih, 21, 57
Ezbet Ḳalamsha, 34, 42, 44

First Cataract, vii, 54, 72

Gardner, Elinor W., 3–4, 56, 60, 66–68, 72–73
Gebel Abusir, 33, 37
Gebel Dakakin, 19–22
Gebel Deshasheh, 25
Gebel er-Rus, 6, 21, 25, 41–42, 44–47, 53, 57, 59, Pls. V–VII
Gebel er-Rus valley, 21
Gebel Hadadin, 26
Gebel Khashab, 26
Gebel Lahun, 35, 41
Gebel Lahun valley, 22
Gebel Mansuriyeh, 23
Gebel Naᶜallun, 14–17, 20, 22, 25, 34–35, Pls. I–II
Gebel Naᶜallun valley, 22
Gerzeh (Girza), 2
Gharaḳ basin, 40
Girza, *see* Gerzeh
Gizeh, 25
Gizeh pyramids, 25
Greco-Roman ruins, 2
Greco-Roman town, 56
Günz-Mindel, ix

Hammam Monastery, 49
Hawara, 11
Hawara Channel, 2, 4, 16, 19, 22, 25, 33–42, 52, 54–57, 59, 61, 67–68, 71–72
Hawara pyramid, 2, 42, 44, 56–57, Pl. IV
Heliopolis, 23
Helvetian, 9–10
Herodotus, 2

Ibwit (Abwit), 17, 22, 33, 37–38
Illahun, *see* Lahun
Ilwet Hialla (Elwat Hialla), 19–20, 35
Isser River, 26, 31

Junker, Hermann, 66

Ḳalamsha, 13–15, 35, 42, 57–59, Pl. V
Ḳalamsha Monastery, 44
Ḳasr Basil, 14, 42–44, 49–51, 53, 57–59, 61, 63, 65–66
Ḳasr es-Sagha, 6–7, 68, Pl. X
Ḳasr es-Sagha series, 36
Kelsey, Francis Willey, 1
Ḳeneh, 71
Kent, England, 35
Kom Aushim (Kom Ushim), 1, 4
Kom Medinet Ghurab (Medinet Gurob), 33, 55
Kom Ombo, 56
Kom Ombo plain, viii, 52, 54, 56, 63
Kom Tima, 13–15, 30–33, 37, 51
Kom Ushim, *see* Kom Aushim

Lahun (Illahun), 11, 37–38
Lahun (Illahun) pyramid, 2, 49
Lamothe, L. J. B. de, 26, 71
Levallois, 36, 45
Libyan Desert, 2, 7
Libyan Plateau, 2, 21–22, 70
Libyans, ix
Lisht, 33–34
Lisht pyramids valley, 21
Little, O. H., 44
Luxor, vii, 5, 19, 24, 54, 56, 63, 71

Mactra subtruncata, 13–14, 16
Martens, Eduard Karl von, 56
Medinet el-Faiyum, 4, 33, 59
Medinet Gurob, *see* Kom Medinet Ghurab
Mediterranean littoral, 32, 54
Mediterranean Sea, vii, ix, 5, 7–8, 10, 26–27, 40, 54, 70
Mediterranean stages, 10, 31, 71
Medway River, 35
Meidum, 13
Meidum pyramid, 14, 33
Meidum pyramid valley, 21, Pl. II
Melanopsis, 16
Meretrix (Callista) chione (Linné), 13
meteorology, 41
Michigan, University of, 1, 4
Micoque, 36, 71
Milazzian, 26, 71
Miocene, 8–10, 12, 28, 70
Moeris, Lake, 2–3, 66
Monastirian, 31
Mousterian, x, 3, 28, 36–57, 59–61, 63, 66–68, 71–73, Pls. IV–VI
Mutelina aegyptiaca Pallary, 33

Nagᶜ Hamadi, 54
Natica spp., 14
Near East, viii, x, 5, 8
Neverita josephinia (Risso), 14
Newton, R. Bullen, 56
North Downs, Kent, England, 35
Nubian sandstone, 5, 7, 24
Nummulites, 6, 15–17

Obermaier, Hugo, 54
Oligocene, 7–9, 15, 17, 19–22, 24, 36–37, 70
Operculina, 6
Ostrea clot-beyi, 15
Ostrea cucullata, 12–13, 15, 21

Palestine, viii, 8
Pallary, Paul, 56
Pecten beds, 12, 14–15, 21
Pecten benedictus, 12–13
Peterson, Enoch E., 4
Philadelphia, 2, 25, 40–41, 44, 56–57, 59, 61–65, Pls. VII, IX
Pironella conica, 23
Pitt-Rivers, Augustus Henry Lane-Fox, vii
Plaisancian, 13
Pleistocene, ix, 3, 7, 9, 16–17, 20–22, 28–69, 71
Pliocene, 3, 9–28, 33, 35, 37, 40–43, 58, 70, Pls. I–III, VI, VIII
Plio-Pleistocene, ix–x, 3, 9, 21–22, 24–29, 34–35, 40, Pl. III
Pontic Pluvial, 10
post-Monastirian, 37
post-Mousterian, 54, 63, 71
post–Upper Pliocene, 71
Psammobia intermedia Deshayes, 14
Ptolemies, 2
Pyrenees, 40

Quaternary, 26, 32, 41

Ravine beds, 5–6, 11, 14
Red Sea, vii, 8–9
Red Sea Hills, 7, 24, 26, 33, 70
Riss-Würm, ix
Roman canal, Pl. IX
Rus, 17, 22, 33, 46
Rus Channel, 33, 36–37, Pl. I
Rus valley, *see* Gebel er-Rus valley

Sadek, Hassan, 9–10
Sahara Desert, 8
Sahara Plateau, ix
Saḳḳara, 25, 34, 57, 70
Schweinfurth, Georg August, vii, 11
Scrobicularia cottardi, Pl. XI
Sebil, 56
Sebilian, 45, 52, 54–56, 60, 62–66, 71–73, Pls. V–VII
Sedment, 6, 16, 23, 32–33, 35, 42
Sedment Monastery, Pl. IV
Shaḳluf Bridge, 13, 42, 57–59, 68, Pl. VIII
Sicilian, 26–27, 71
Sicilian land-bridge, ix
Sinai, 5, 8
Solutreo-Magdalenian, 54
Spain, 54
Suess, Eduard, 10
Suez, 8–10; Gulf of, 8, 10; Isthmus of, 10
Suez road, 23
Swiss Lake-Dwellers, ix
Syria, viii

Tardenoisian, 52, 54, 65
Tebtunis, 42, 44, 57, 59
Tellina sp., 14
Terebratula moysae Mayer Eymar, 14
Tertiary, ix, 5, 7–8, 26
Tethys, 5
Thames River, 35
Thebes, 48
Thompson, Gertrude Caton-, *see* Caton-Thompson, Gertrude
Turritella, 15, 17
Tutun, 43, 49–51, 53, 61, 63, 65
Twelfth Dynasty, 2
Tyrrhenian, 31

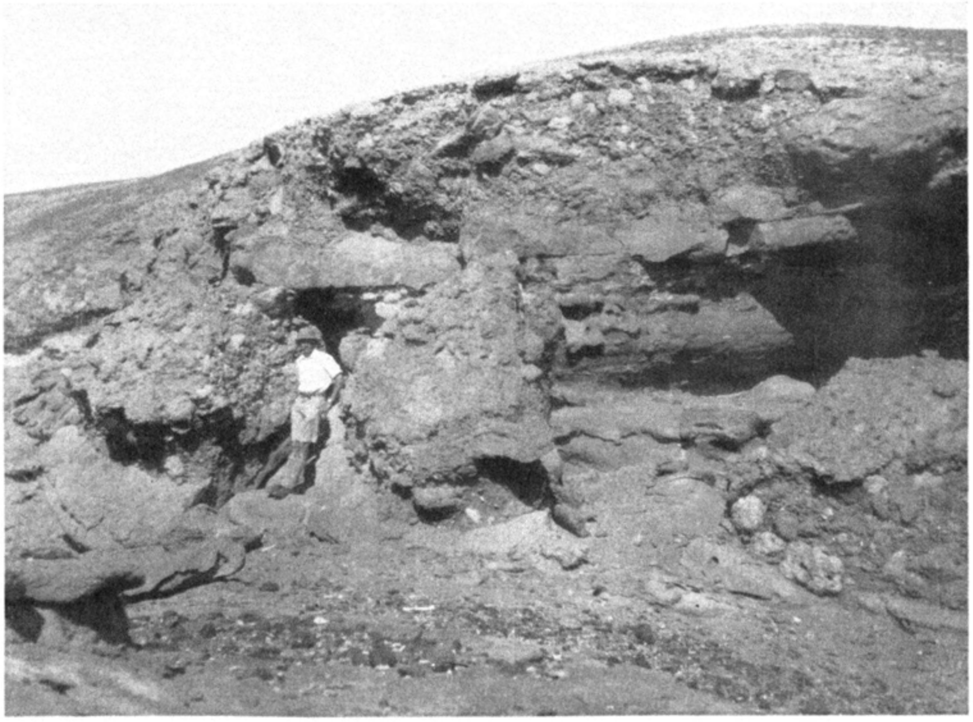
Umm el-Atl, 61
Unio gaillardoti Bgnt., 33, 56
Unio schweinfurthi Martens, 56
Unio Vignardi Pallary, 56
Unio willcocksi Bullen Newton, 56
Ur-Nil, 8–9, 70

Venus (Chamelaea) gallina Linné, 14
Venus plicata Gmel., 13–14
Vienna Academy, 66
Vignard, Edmond, viii, 52, 54, 63, 65
Vivipara unicolor, 56

Wadi Halfa, 56
Wadi Muellih, 36
Wadi Rayan, 36, 44
Wadi Rayan beds, 11
Wadi Rayan series, 5
Wasta, 33, 35, 44
Weald, 35
Wealden, 7

PRINTED IN U.S.A.

A



B

Pliocene Bowlder Conglomerate

A.—In the side of the Rus Channel. *B*.—On the east side of Gebel Naʿallun

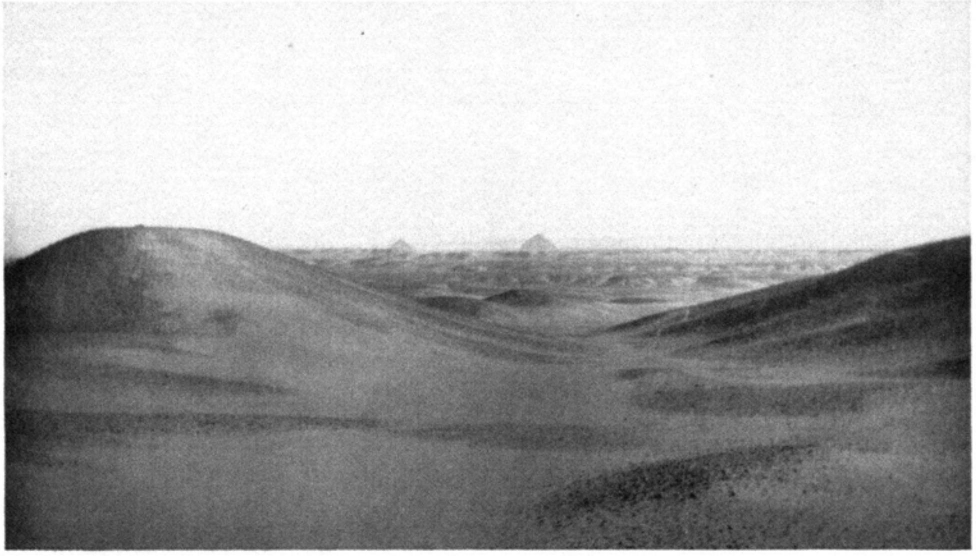
PLATE II

A

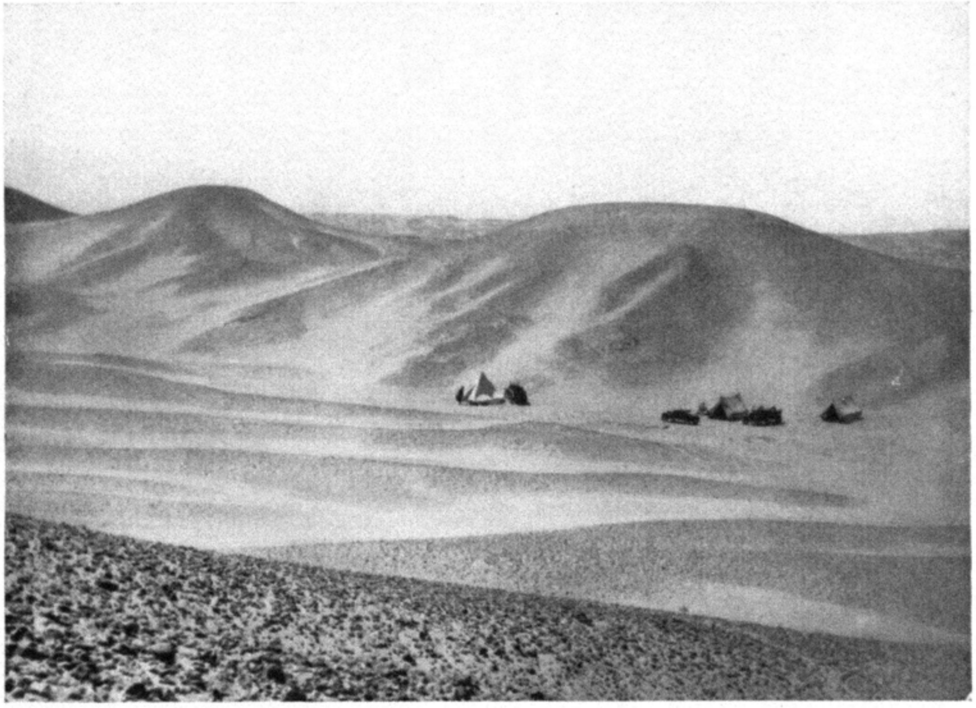
B

A.—Cross-section of the Pliocene-filled Meidum pyramid valley (p. 21), forming the cliffs overlooking the Faiyum. Old valley floor of slipped Eocene in foreground, supporting laminated fine-grained deposits, passing up into gravels at the top of the cliff. *B*.—Topography cut in Pliocene gravels 100 feet thick. Gebel Naʿallun (pp. 15 and 22), looking toward the Faiyum from about 150 meters above sea-level.

PLATE III



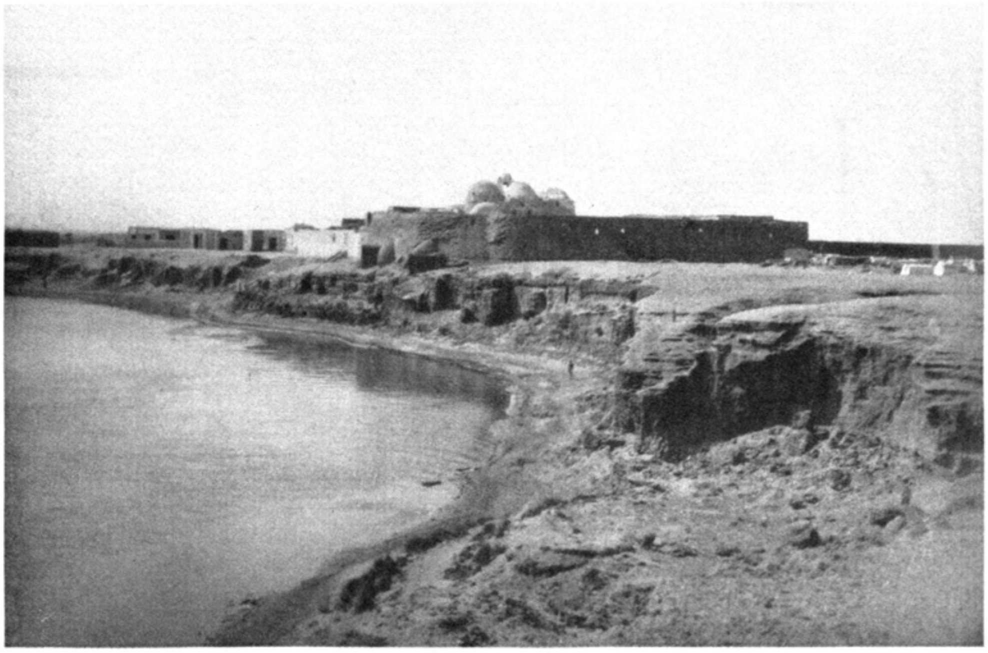
A



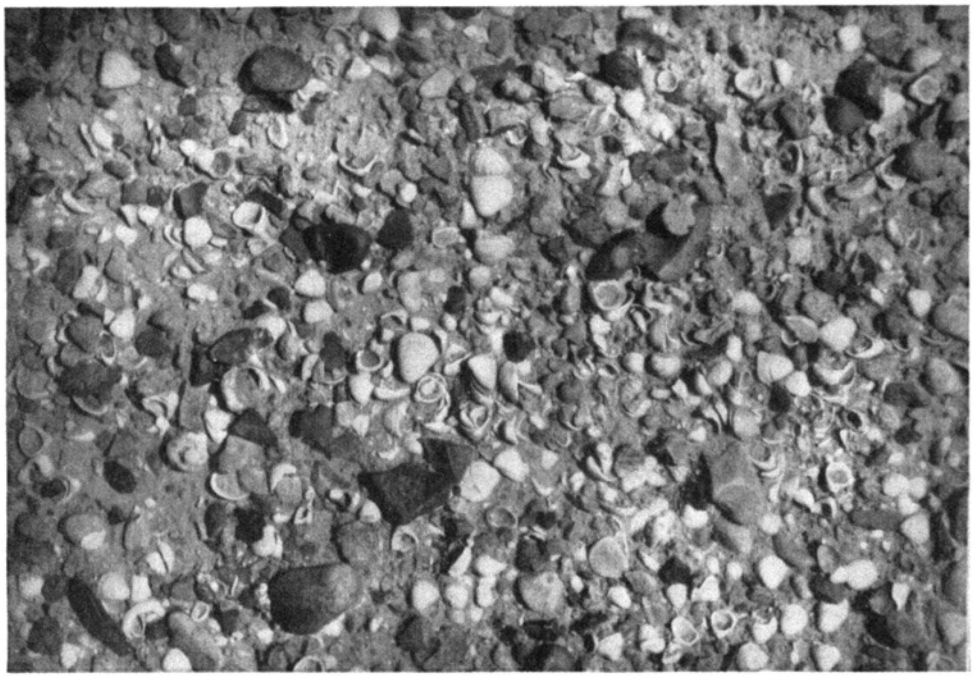
B

Plio-Pleistocene Terraces and Sanded-up Pliocene Country Southwest of the Dahshur Pyramids (Seen in *A*)

PLATE IV



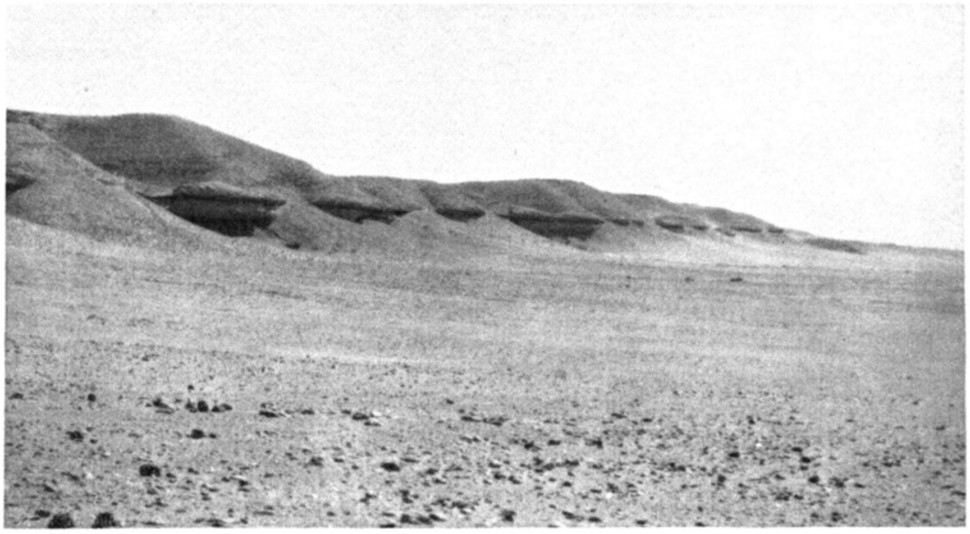
A



B

A.—The gravels of the Paleolithic channel dissected by the Bahr Yusef at Sedment Monastery. The implements shown in text Figs. 8 and 9, with others, were found in the gravels near here. *B*.—Surface of the Mousterian (112-ft.) beach near the Hawara pyramid, showing shells of *Corbicula artini* and *C. innesi* (cf. Plate XI, *B*).

PLATE V

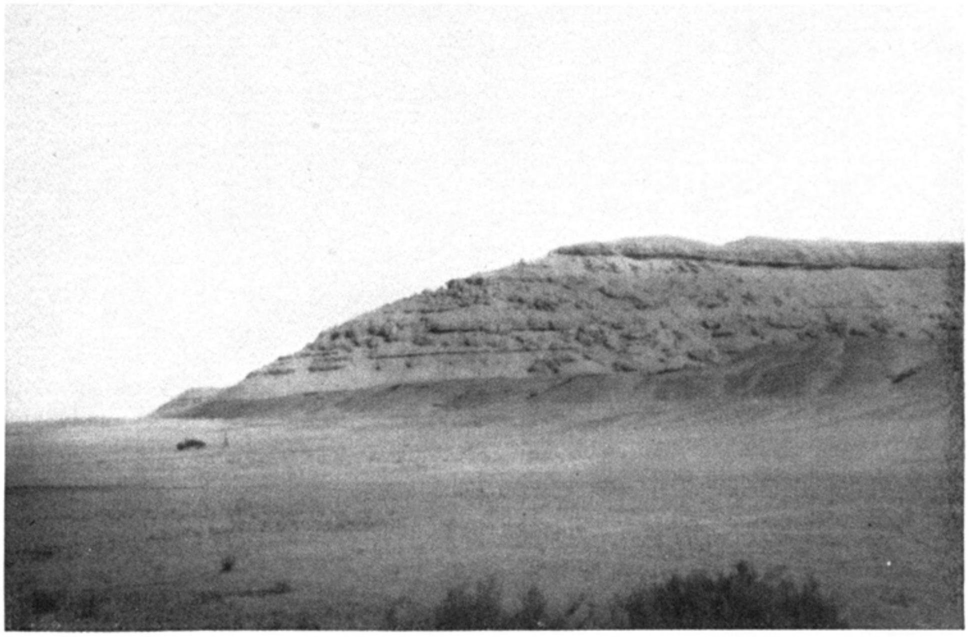


A

B

A.—The Mousterian beach banked on Eocene limestones, at the implement site under Gebel er-Rus. *B*.—Leveling the marginal gravels of the Mousterian (112-ft.) lake, near Ḳalamsha. The cliff on the right was cut back by the Sebilian (92-ft.) lake, and the numerous fanlike gullies by streams running into it. It can be seen that the downwash-covered plain below has been very little dissected since the waters of the Sebilian lake retreated from it.

PLATE VI



A

B

A.—The Mousterian beach running round the foot of Gebel er-Rus, at the top of which the Pliocene conglomerate simulates a terrace. *B*.—The Sebilian (92-ft.) lake deposits (forming a fan-like feature) south of Gebel er-Rus, as seen from the summit. Here the prominent cliff was cut by the 74-foot lake (cf. Plate V, *B*).

PLATE VII

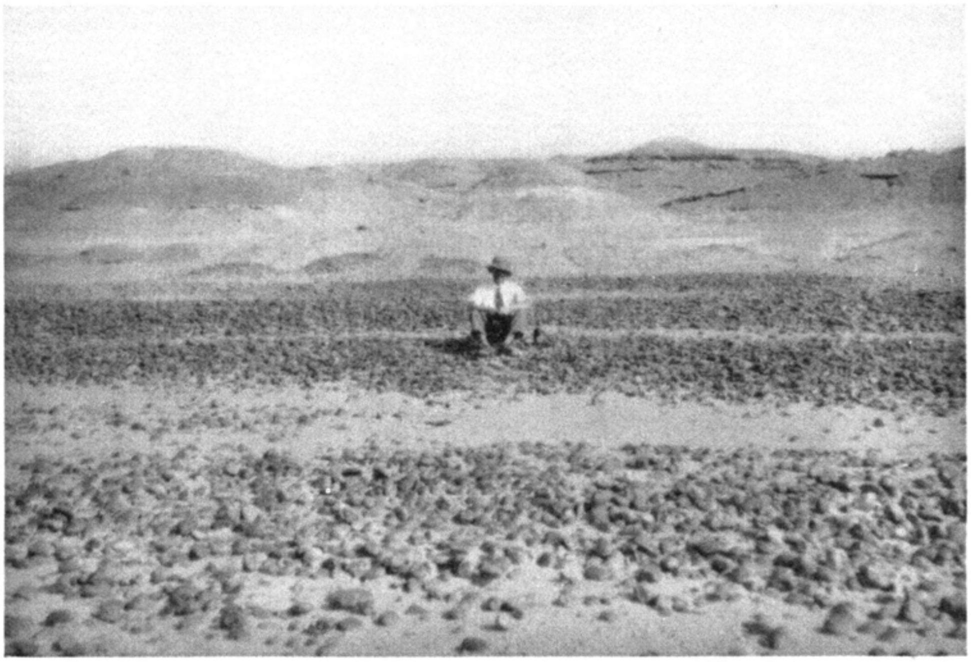
A

B

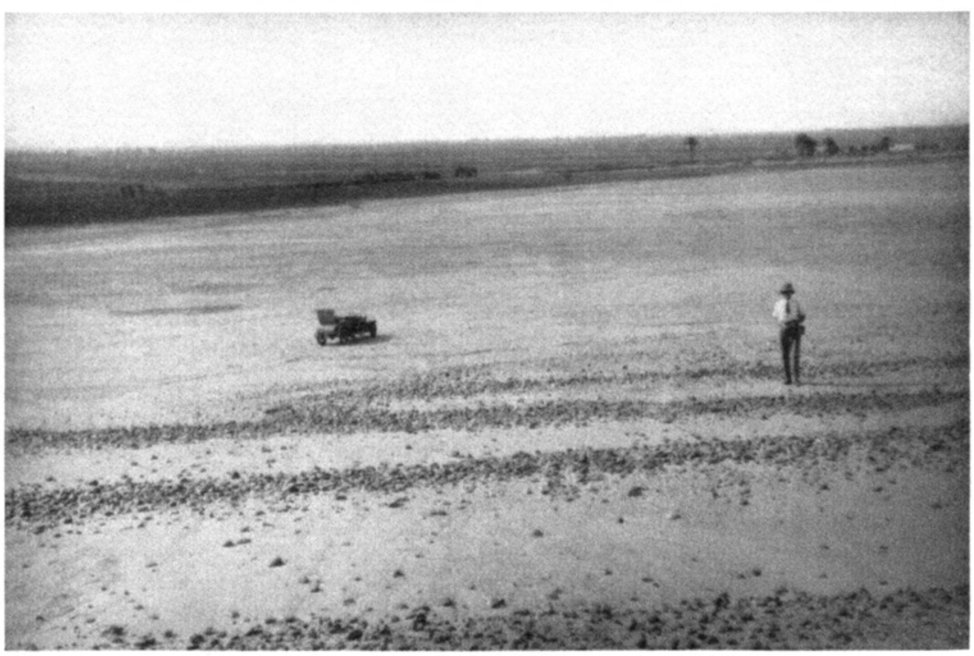
THE SEBILIAN (92-FOOT) BEACH

A.—The storm beach circling the bay north of Gebel er-Rus (seen in distance). *B*.—At the prolific implement site at Philadelphia, where the deposits have been cut back to form a low cliff by the water of the 74-foot lake.

PLATE VIII



A

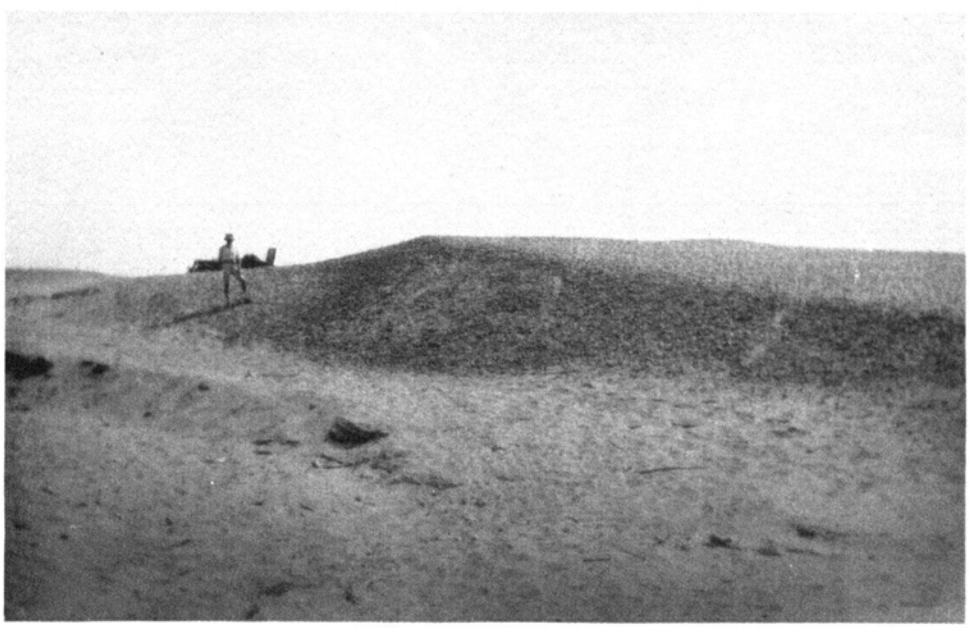


B

Part of the Series of Ten Small Beaches at Shaḳluf Bridge (See Text Figs. 20 and 3). The Cliff Behind Consists of Fossiliferous Pliocene Strata

PLATE IX

A

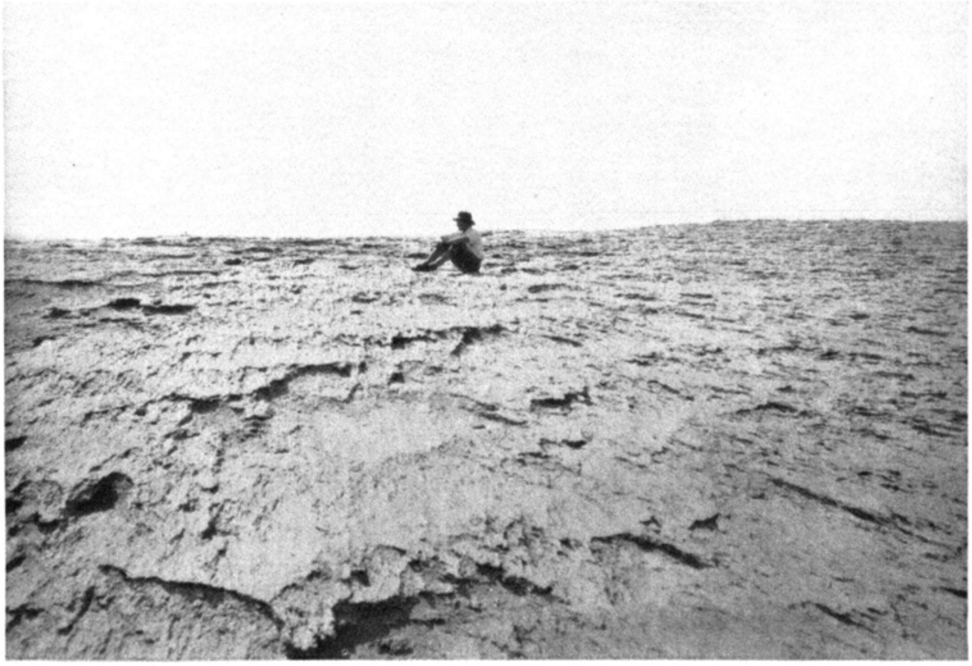


B

The Storm Beach of the 74-Foot Lake, North of the Ruins of Philadelphia. The Ridge to the Left in *A* Is the Derelict Roman Canal (Bahr Wirdan)

PLATE X

A



B

Rain and Wind Erosion in the Faiyum

A.—A rainstorm from the southwest crossing the desert north of the lake, as seen from the temple of Ḳasr es-Sagha. Note the curtain of sand rising in front. *B*.—Hard Eocene limestone fluted by wind-borne sand, above Ḳasr es-Sagha.

PLATE XI

A

B

THE BIRKET ḲARUN, THE MODERN RELIC OF THE FAIYUM LAKE

A.—A still day on the north (desert) shore at Dimei, showing fringing dunes with tamarisk. *B*.—A rough day on the south (cultivated) shore; notice the dwindled "storm beach," composed of shells of *Cardium edule* var. *clodiensis* and *Scrobicularia cottardi*.

THE EASTERN FAIYUM DESERT