To the Graduate Council:

I am submitting herewith a dissertation written by Douglas J. Brewer entitled "Cultural and Environmental Change in the Fayum, Egypt: An Investigation Based on Faunal Remains." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

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We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Provost
and Dean of The Graduate School

CULTURAL AND ENVIRONMENTAL CHANGE IN THE FAYUM, EGYPT: AN INVESTIGATION BASED ON FAUNAL REMAINS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Douglas J. Brewer

June 1986

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To Dianne and Lucia

ACKNOWLEDGMENTS

I would like to thank the American Research Center in Egypt and the Smithsonian Institute for providing the funds for this research. I would also like to thank Dr. Ahmed Kadry, President of the Egyptian Antiquities Organization, and to the Permanent Committee for their support. Dr. Ali El-Khouily, Director of Middle Egypt, Mr. Ali Bazidi, Chief Antiquities Inspector, Fayum, Mr. Magadi El Said Abu Alia, Antiquities Inspector, and Sabhey Samuel Yogoup, Geology Inspector deserve special thanks for their deep concern and interest in the project.

I am also more than appreciative for the support I received in Egypt from the American Research Center. I would especially like to thank the Cairo directors, Dr. Robert J. Wenke and Dr. Nanette M. Pyne and the executive director Dr. Paul E. Walker for helping secure extra funds to enable the completion of the zoological aspect of my research.

Special thanks are extended to my dissertation committee, David Etnier, Donald Grayson, Paul Parmalee, and Gerald Schroedl. I owe the greatest debt of gratitude, however, to my friends and mentors Dr. Donald K. Grayson, Dr. Paul W. Parmalee, and Dr. Robert J. Wenke.

ABSTRACT

Archaeological investigations in the Fayum have identified presence two distinct cultural assemblages: Fayum B, which has been classified as an epi-paleolithic culture possessing a generalized hunter-gather economy, and Fayum A, which is thought to represent an early Neolithic economy based on agriculture and domestic animals.

Because relatively little is known about the functional aspects of Fayum A and B lithic tool assemblages, it is impossible at this time to attribute changes in tool frequency to changes in subsistence practices. The collection and analysis of faunal remains in regard to their environmental as well as their cultural significance remains the most important record documenting cultural change in this area.

Archaeological sites to the north and southwest of Birket Qarun (Lake Qarun) contain a well preserved faunal record reflecting the transition from an epi-paleolithic to a Neolithic economy. Faunal remains from these areas were systematically collected and subjected to analysis at three separate scales of investigation:

1. Standard taxonomic identifications were conducted for the purpose of assessing Fayum A and B subsistence practices and to aid in the reconstruction of the prehistoric environment.

2. The incremental growth structures of Pisces: Clarias spp. were studied to assess the seasonal occupation of the Fayum area.

3. Isotope analysis was conducted on bone recovered from Fayum archeological sites to estimate changes in relative temperatures during the late Paleolithic-early Neolithic period.

The results of these investigations suggest that no detectable differences exist between Fayum A and B regarding the pattern of animal exploitation during the period that agriculture was becoming established. These findings contradict current interpretations regarding Fayum A cultural assemblages as representative of an early sedentary lifestyle and suggests that these peoples possessed an economy similar to that of the earlier epi-paleolithic Fayum B culture.

PREFACE

Studies involving the analysis of faunal remains recovered from ancient Egyptian cultural assemblages are still considered by many researchers working in Egypt as an expensive luxury. This investigation and its presentation have been designed to demonstrate the valuable contribution that faunal studies can provide. Because the information contained in this work is of interest to a cross disciplinary audience, a great deal of time has been invested in the editing and tailoring of the various chapters so that the reader is not encumbered by a mass of quotes and citations containing terms and concepts indicative of a single discipline. Towards this goal, the presentation of information has been reported in a concise a manner as possible, while still retaining the scientific integrity needed for a study in zooarchaeology. It is hoped that by reading this work the importance of a properly planned faunal study will be realized and such studies will begin to become an intricate part of investigations dealing with the cultures of ancient Egypt.

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INTRODUCTION

The Fayum Depression is one of the major oases of Egypt's Western Desert, covering an area of 12,000 square kilometers with a general slope to the northwest where Birket Qarun (Lake Qarun) is situated (Figure 1). This lake, which occupies the lowest part of the depression, is 44 meters below sea level and is bounded by a huge vertical scarp that encircles the northern and western shores.

Although located within the Western Desert, the Fayum is often looked upon as part of the Nile Valley (Wendorf and Schild 1976). The eastern boarder of the Fayum is less than 15 km from the Nile and the Fayum has been connected to the Nile via the Bahr Yousef canal (Hawara Channel). Deposition of Nilotic silts in the Fayum Depression during prehistoric as well as historic times demonstrates that the Fayum has been connected at least intermittently with the Nile throughout its recorded history.

The presence of a rich Nilotic-type environment surrounded by a harsh desert environment offers a unique opportunity to investigate cultural changes in response to changing environmental conditions. Changes in Birket Qarun's productivity brought about by changes in climatic conditions should result in detectable changes in prehistoric cultural manifestations.

The cultural history of the Fayum area has been studied by three separate research teams that have proposed two generalized models, both of which attempt to relate perceived changes in cultural manifestations to environmental change. However, neither model attempts to explain the

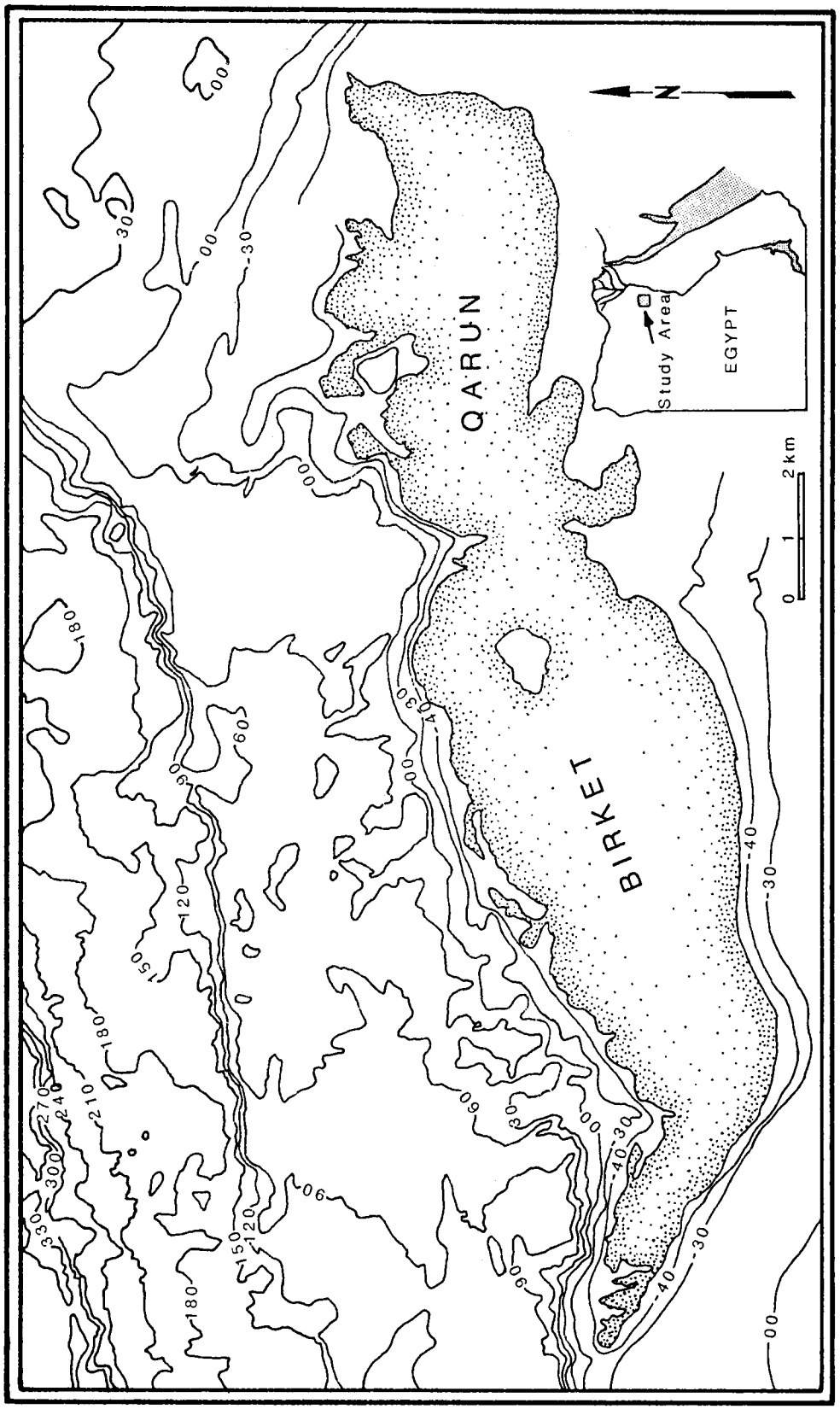


Figure 1. Study area north of Birket Qarun.

cultural changes in any detail other than as a general correlation to changing environmental factors.

The first significant prehistoric investigations of the Fayum did not begin until the late 1920s when Caton-Thompson and Gardner (1926, 1929, 1934) investigated cultural remains around the shores of Birket Qarun. They concluded that two lakes connected at least intermittently with the Nile had succeeded each other in the depression. The first lake was Pleistocene in age and reached an elevation of 34 m above sea level. The second lake rose to 18 m above sea level. In addition, Caton-Thompson and Gardner were able to locate three other stages of the second lake that represented different lake levels: a +6-10 m stage, a +4 m stage, and a minus 2 m stage.

A number of archaeological sites were associated with each stage of the second lake. According to Caton-Thompson and Gardner (1934) the earliest settlements were associated with the 10-6 m stage and were referred to as Fayum A. Fayum A sites contained pottery, bifacial tools, and concave-based projectile points. It was thought Fayum A sites represented a fully developed Neolithic economy based on wheat-barley agriculture and domestic animals (Caton-Thompson and Gardner 1934). The settlements associated with the 4 m and minus 2 m lake levels were called Fayum B. Fayum B settlements lacked any evidence of pottery, domesticates, or an advanced lithic technology capable of producing bifacial tools. Caton-Thompson and Gardner (1934) believed that these cultural manifestations were from a Mesolithic group that

occupied the Fayum Depression after the introduction of the Neolithic Fayum A culture.

In 1969 Wendorf and Schild (1976) conducted a survey along the northern rim of the Fayum Depression. They determined that at least four succeeding episodes of lake transgression had occurred. From the sequence they constructed through the use of stratigraphic, radiocarbon, and archaeological evidence, they discovered that Caton-Thompson and Gardner's Fayum B had in fact preceded the Neolithic Fayum A. A third survey conducted in 1980 substantiated Wendorf and Schild's findings (Wenke et al. 1983). Fayum B cultural deposits have now been securely dated to around 5500 BC, Fayum A deposits, to around 4000 BC (Wendorf and Schild 1976; Wenke et al. 1983).

Although evidence demonstrating the existence of a correlation between changes in lake levels and changes in cultural entities has been well documented in the Fayum, little effort has been directed toward determining the underlying causes for the perceived material differences between Fayum A and B cultural assemblages. Because Fayum A cultural assemblages possess characteristics indicative of a Neolithic economy and because the Fayum has produced one of the earliest dates for such an economy in Egypt (Hassan 1979; Butzer 1976), explanations regarding the apparent transition of Fayum B to Fayum A have been subsumed under general hypotheses regarding the development of agriculture. Traditional views such as Childe's (1929) desiccation hypothesis, Wittfogel's (1957) search for cultural and environmental regularities in the rise of civilization and White's (1948) theory of the state-church have been

regarded at one time or another as possible explanations for a transition of this type.

Several explanations regarding the inception of a food producing economy limited to North Africa, the Nile Valley, and the Sahara have also been offered (Clark 1971, 1976; Harlan et al. 1976; Shaw 1976; Smith 1976). However, these hypotheses, like the previous ones, revolve around a similar theme: accounting for the change from hunter-gatherer to food producer by environmental and demographic change.

Environmental and demographic changes may nominally account for differences between Fayum A and B cultural assemblages, but the types of environmental changes that occurred and how they influenced the various groups as well as what adaptations had to be made so that differences perceived in the archaeological record can be interpreted have not been fully addressed using models based upon these hypotheses. Utilizing the ecological principles of generalization and specialization might provide a better approach towards understanding the transition between Fayum B and A.

In the chapters that follow it is be argued that Fayum B population and cultural stability was a function of resource availability and predictability. Changes in environmental parameters affected these characteristics and caused the disappearance of the Fayum B culture from the archaeological record and subsequent appearance of the Neolithic Fayum A culture. These changes can be detected in the archaeological record through analysis of faunal materials at three separate scales of investigation:

1. Standard taxonomic identifications and interpretations.
2. Microscopic analysis of structural features (to assess seasonal occupation of Fayum A and B cultural areas).
3. Chemical (isotopic) analysis of skeletal elements (to estimate changes in temperature and how such changes may have affected prehistoric inhabitants).

The ultimate goal of this research endeavor is to shed light on the causes for the observed differences between those archaeological phenomena known as Fayum A and B.

CHAPTER 1

PROCUREMENT STRATEGIES

In ecology, the terms generalization and specialization refer to two extremes of a continuum. These terms are classifications used to describe a specie position within a community relative to other species of that community (Wittaker 1970). Generalists have more flexible habitat requirements than specialists and thus are better able to withstand periods of great stress. Highly specialized organisms are more efficient than generalists within their own niche, but their tolerance to habitat change is not as great (MacArthur 1972).

The terms generalization and specialization have also been used to describe various resource procurement strategies practiced by human populations (e.g., Cleland 1966, 1976; Dunnell 1967, 1972; Segraves 1974). A specialized procurement strategy has been defined as one in which a group relies almost totally on one or a few resources; in a generalized strategy a group uses a wide variety of resources. Ethnographic accounts of hunter-gatherer groups living in harsh environments (such as deserts) have described what can be classified as a generalized subsistence system (Steward 1933, 1938, 1941; Birdsell 1953; Lee 1969, 1972a, 1972b). Groups dependent upon agriculture are considered in general to possess a specialized resource base.

If a cultural group uses a variety of resources it would be well suited to an unpredictable environment, given current ecological theory, because the failure of one resource would be less likely to cause severe

stress upon the group (Dunnell 1967, 1972; Segraves 1974). Groups that use specialized systems, such as those dependent upon agriculture, would typically out-compete those using a generalized one. However, in an unpredictable environment a human group practicing a generalized procurement strategy would possess a more flexible resource base, and consequently could adjust more easily to hardships. That is, in the event of a change in resource availability, different resources could be more easily substituted for one another (Segraves 1974).

The concept of generalization and specialization have been implicitly applied to prehistoric Fayum cultures. The people responsible for the cultural manifestations referred to as Fayum B are thought to represent hunter-gatherers possessing a generalized subsistence system. Fayum A groups are believed to have been sedentary agriculturalists subsisting primarily on domesticated plants and animals, thus relying on a specialized resource base (Caton-Thompson and Gardner 1934; cf. Wendorf and Schild 1975, 1976). Neither premise, however, has been tested.

Because Egyptian deserts are among the most arid regions in the world, their air temperatures among the highest and rainfall and relative humidity among the lowest of all African and Asian deserts (Migahid and Abd el Rahman 1953), severe restrictions are imposed on the availability and predictability of resources. Water is the most important factor determining the presence of resources in the desert (Louw and Seely 1982; Osborn and Helmy 1980).

Throughout the last 10,000 years, as today, Birket Qarun must have been the central focus of human occupation in the Fayum. The lake acted

as a stabilizing factor in the human ecology of the area. It could be relied upon as a source of fish, molluscs, and waterfowl. Additionally, the local terrestrial fauna also must have relied at least in part on the lake and would have congregated near it. In short, the lake offered a factor of stability for the region.

Geological evidence, however, implies that the lake's history has been characterized by several drastic changes in water level (Wendorf and Schild 1976; Caton-Thompson and Gardner 1934). These changes no doubt had a negative impact on resource predictability, creating an environment conducive to exploitation by mobile nonsedentary cultural groups, with mobility offering a more effective means of gaining access to alternate resources. Current thinking regarding the disappearance of the Fayum B culture vis-a-vis a specialized agricultural one appears consequently, to contradict the ecological principles outlined above. Theoretically, a generalized economic system rather than a specialized one, should in the long run, have prevailed in a harsh unpredictable environment such as the Fayum. This phenomenon warrants further investigation and may be the key to understanding the reasons behind the Fayum B to A transition.

Human Subsistence Strategies

Three main points are presented regarding generalized human subsistence strategies:

1. People adopting a generalized subsistence strategy exploit a variety of resources and such a strategy is relatively stable even in an unpredictable environment.

2. Population mobility is a function of resource predictability, availability, and distribution.
3. Environmental changes affecting resource availability, predictability, or distribution can affect human procurement strategies.

Environmental change in any area will differentially affect the resources of that area. Some resources may become less productive, others more productive. Depending upon how resources are affected, a cultural system may need to respond to these changes.

An environmental change might have little or no effect upon those resources most heavily utilized by a cultural group or such a change might decrease the productivity of one or more important food species. Such a decrease would necessitate an adjustment in procurement strategies either in terms of technical change regarding food procurement or a behavioral change emphasizing other resources or other areas. These options are not necessarily mutually exclusive.

Unfortunately, the archaeological record does not reflect all changes. At best, the recovered sample will represent an "average" over time of the compiled cultural materials (cf. Binford 1981). Consequently, only long term or general trends will most likely be detected. Cultural adjustments to changes in environmental conditions, therefore, must first be recoverable, and then, determined to be the result of or at least correlated with a changing environment.

Gould (1980) noted that aboriginal nomads highly value portable cultural materials. Using tools that are constructed as the need arises

and discarded when no longer needed is one means of achieving portability. Binford (1972, 1973, 1977) refers to such practices as expedient. Very little time and effort are spent in the manufacture of such tools and they are generally discarded where they are used (Binford 1977). If tools were expedient and left at their point of manufacture and use, functional analysis of these tools could provide evidence of relationships between changes in certain procurement practices and changes in the environment. However, in such technologies, technological innovations involving expedient tools are generally quite rare and are thus likely to reflect only major changes in procurement practices.

Unfortunately, analyses have not yet been conducted on Fayum lithic materials. However, faunal remains, which can be considered artifacts of an expedient nature, can through proper analysis provide important information regarding changing procurement practices and changing environmental parameters. For example, the identification and analysis of faunal remains can indicate what taxa were being utilized and in what relative numbers. Additionally, the different environmental requirements needed by each identified taxon can provide valuable information regarding the environmental conditions of Birket Qarun during Fayum A and B times. Finally, analysis of incremental growth structures from selected taxa can provide insights regarding the seasonal nature of resource aquisition.

Responses to environmental change are not, however, limited to changes in technology or changes in faunal appropriation. Another response to environmental change is change in population aggregation. If

changes in the environment decrease productivity, the population might disperse into smaller groups to obtain food; if environmental change increased productivity, greater populations could be supported in a single area. Changes in productivity could also result in total abandonment of the area if productivity decreased; if productivity increased, continued stay in one area could result in the abandonment of others.

If it can be assumed that water is the factor controlling resource availability in Egyptian deserts, then prehistoric populations of the Fayum out of necessity must have placed their settlements near sources of water. In fact, archaeological assemblages from a variety of Western Desert localities covering a wide range of time appear to be highly correlated with areas where water was immediately available (cf. Wendorf and Schild 1980a, 1980b; Wendorf, Close, and Schild 1985). The predictability of resources in these areas would then determine the procurement strategies of the prehistoric inhabitants. Changes in environmental conditions resulting in changes in productivity could elicit responses similar to those outlined above.

Although some studies involving seasonal occupation along the Nile have been published (e.g., Wendorf and Schild 1980b), studies involving seasonal procurement strategies for prehistoric desert populations are virtually nonexistent. Consequently, studies involving procurement strategies of prehistoric Western Desert populations must begin with an in depth study of a well-documented resource center, Birket Qarun.

Environmental Change and Archaeology in the Fayum

During the past 10,000 years the environment of the Fayum area has undergone several major changes that have been documented by Birket Qarun's fluctuating water level (Table 1). Caton-Thompson and Gardner (1934) were the first to propose that significant environmental changes had occurred in the Fayum. They determined that two lakes, one preceding the other, had occupied the depression (Figure 2).

The first lake was Pleistocene in age and reached an elevation of 34 m above sea level. Caton-Thompson and Gardner (1934) determined the age of the lake on the basis of rolled Levalloisian tools associated with shells of Corbicula in gravel deposits resting on bedrock in the eastern part of the depression. According to Caton-Thompson and Gardner (1934), the Pleistocene lake then fell to a much lower level or disappeared altogether.

The second lake rose to a level of 18 m. As this lake receded, people using Neolithic cultural material occupied the lake's shores. A +8 m (6-10 m), +4 m, and a minus 2 m stage were identified as belonging to the second lake. Several archaeological sites were associated with each of these lake stages. The earliest settlements according to Caton-Thompson and Gardner (1934) were associated with the +8 m stage and were referred to as Fayum A. Fayum A sites contained pottery, bifacial tools, and concave-based projectile points. Caton-Thompson and Gardner thought that these communities represented a fully developed Neolithic society dependent upon wheat-barley agriculture and domestic animals but one supplemented by hunting and fishing. They estimated the age of

Table 1. Water level fluctuations of Birket Qarun.

Lake	Lake Elevation in Respect to Sea Level	Age/Date
	(Caton-Thompson and Gardner 1934)	
1	+34 m	Pleistocene
2	+10-6 m	Neolithic
	+4 m	Neolithic
	-2	Neolithic
	(Wendorf and Schild 1976)	
Paleomoeris	+15m	7000 BC
Premoeris	+17 m	5500 BC
	+12 m	
Protomoeris	+15 m	
	+24 m	5110 BC
	+9 m	
Moeris	+23 m	2700 BC
	(Ball 1939 and Shafei 1940)	
Birket Qarun	decline to modern level	323 BC

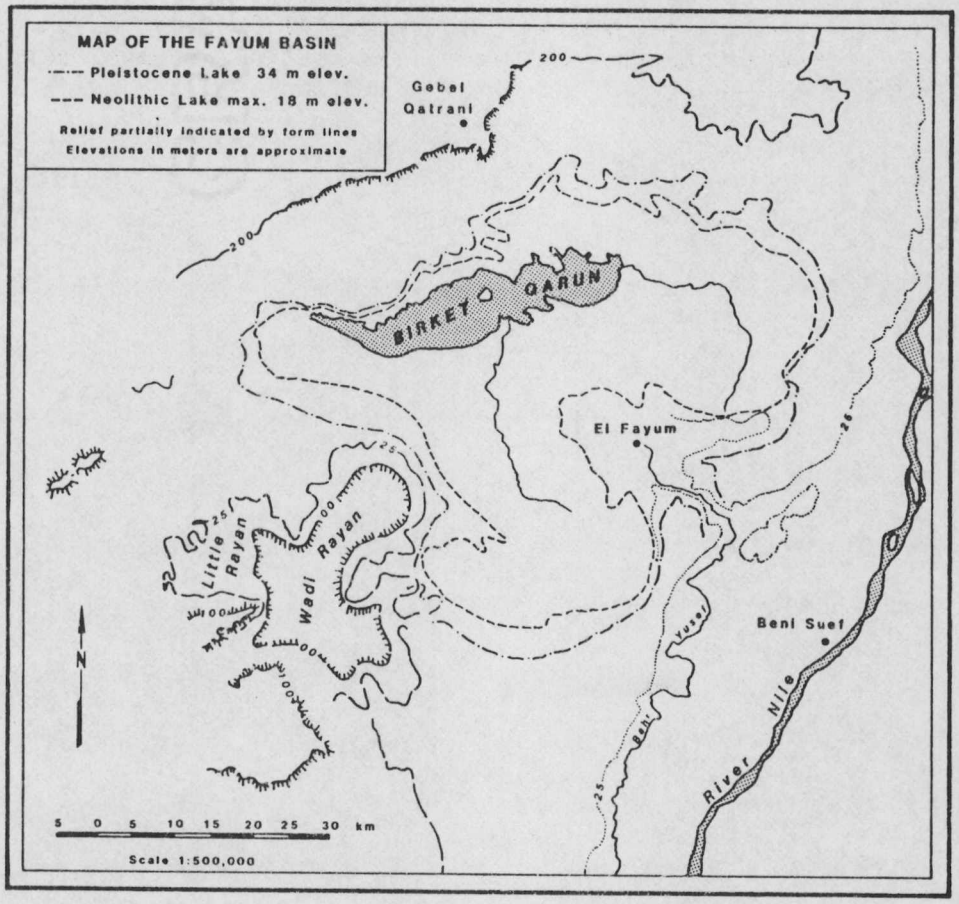


Figure 2. Map of the Fayum Depression indicating the extent of two earlier lakes as defined by Caton-Thompson and Gardner.

Fayum A sites to be ca. 5000 BC. There are now a series of radiocarbon dates for Fayum A sites ranging from 3200-4400 BC (Wendorf, Schild and Said 1970; Wendorf and Schild 1976; Wenke et al. 1983).

Settlements associated with the +4 m and minus 2 m lake levels were termed Fayum B and described by Caton-Thompson and Gardner (1934) as a lingering unprogressive Mesolithic group. Fayum B cultural tool assemblages were predominantly composed of unifacially flaked, often backed blades and bladelets. No evidence of pottery or domesticates were found associated with Fayum B sites.

Wendorf and Schild (1976) determined in their later study that the lacustrine deposits as well as the shore features of the Fayum Depression recorded at least four successive episodes of lake transgression (Figure 3). Additionally, they also found that Caton-Thompson and Gardner's Fayum B culture preceded the Fayum A culture.

Wendorf and Schild (1976) referred to the oldest lacustrine deposits as having been derived from the Paleomoeris Lake. Judging from the thickness of the diatomites, the lake had a long history. Although no radiocarbon dates were available, they decided that the highest level of the lake occurred prior to 7000 BC, which correlates with the high Nile level known as the Arkin Aggradation (Wendorf and Schild 1976; Wendorf, Schild, and Said 1970).

The next episode of lake transgression is better documented and is referred to as the Premoeris Lake. Archaeological materials analogous to Caton-Thompson and Gardner's Fayum B were associated with deposits from this lake period. Three Fayum B sites were found in association with this lake and all three sites yielded evidence of seasonal water

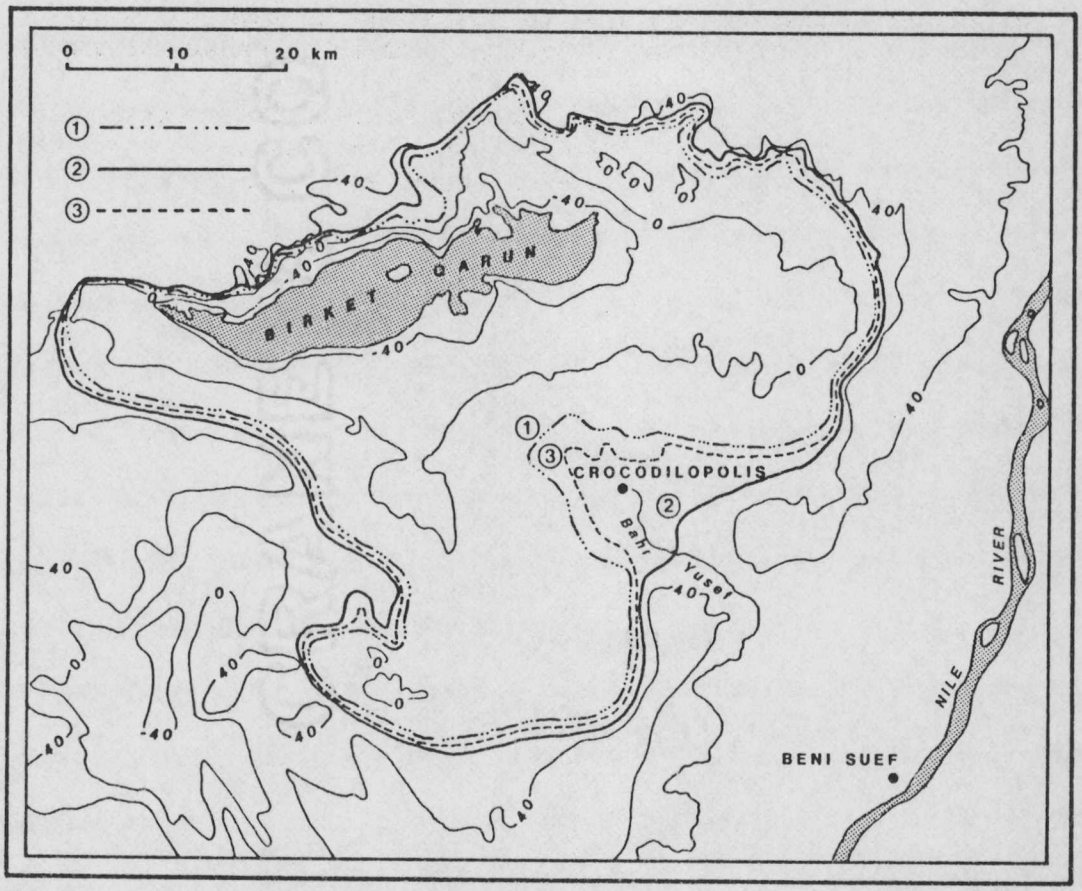


Figure 3. Map of the Fayum Depression indicating the extent of three earlier lakes as defined by Wendorf and Schild.

1. Maximum extent of Premoeris Lake.
2. Maximum extent of Protomoeris Lake.
3. Maximum extent of Moeris Lake.

fluctuations. Two sites produced the same radiocarbon date (6150 and 6120 BC) and were of the same elevation, +15 m. Wendorf and Schild could not determine the precise placement of the occupations within a seasonal framework. They thought, however, that the sites might have been occupied during an annual low water phase presumably to take advantage of exposed rock outcrops for fishing (Wendorf and Schild 1976). One occupational level showed evidence that the lake level may have exceeded 17 m above sea level. A radiocarbon date of 5500 BC taken at 12 m above sea level indicates that from its maximum level the Premoeris Lake receded well below 12 m.

The Premoeris Lake may also have been correlated with a short-lived episode of Nile aggradation reported from south of Luxor and dated to 6400 _ 160 BC (Schild 1968). The resulting formation has been referred to as the Elkab Formation (Vermeerch 1970).

Deposits from the next period of lake transgression, referred to as the Protomoeris Lake, are also associated with a period of Nile aggradation, dated to 5190 BC (Wendorf and Schild 1976). Lake deposits indicate that a high lake level (above 19 m) existed around 5110 ± 120 BC. Stratigraphic sequences from this period show that this lake probably reached the highest elevation (+24 m) of all known stages (Wendorf and Schild 1976).

After the Protomoeris Lake maximum the water level fell to well below nine meters. Wendorf and Schild (1976) believe that a very low lake level or no lake at all existed for a relatively long period of time. This interval has been suggested as an explanation for the total

absence of archaeological remains for the period from ca. 5000 to 4000 BC.

With the next period of lake transgression, the rising Moeris Lake is associated with pottery, domestic animals, and other artifacts characteristic of Caton-Thompson and Gardner's Fayum A complex. The lowest elevation (+15 m) and the earliest date (3910 ± 115 years BC) occur at Caton-Thompson and Gardner's (1934) site R, which corresponds to Wendorf and Schild's (1976) site E29G3. Kom W, (Figure 4) the type site for Fayum A, is 2 m higher than the R site and is dated to 3860 ± 115 years BC. Wendorf and Schild (1976) believe that if the lake did fluctuate annually, the two sites were probably contemporaneous. Moeris Lake slowly rose throughout the period of the Fayum A Neolithic; by the end of the Kom W occupation, the Lake probably stood 20 m above sea level. Following this brief event, the lake continued to rise to its maximum (around +23 m) during the period of the Old Kingdom (ca. 2700-2215 BC).

Ball (1939) and Shafei (1940) have traced the later history of Lake Moeris (Birket Qarun). They concluded that during the reign of Amenemhat I (ca. 1991-1961 BC, Middle Kingdom), the maximum lake level stood about 18 m above sea level. Following the Old Kingdom maximum, the lake level fell; engineering activities at the lake during Amenemhat I's reign may have been to prevent further decline in the level of the lake.

The decline of the lake to its modern level may be attributed to the barrage constructed at Lahum by Ptolemy I (Ptolmeic Period ca.

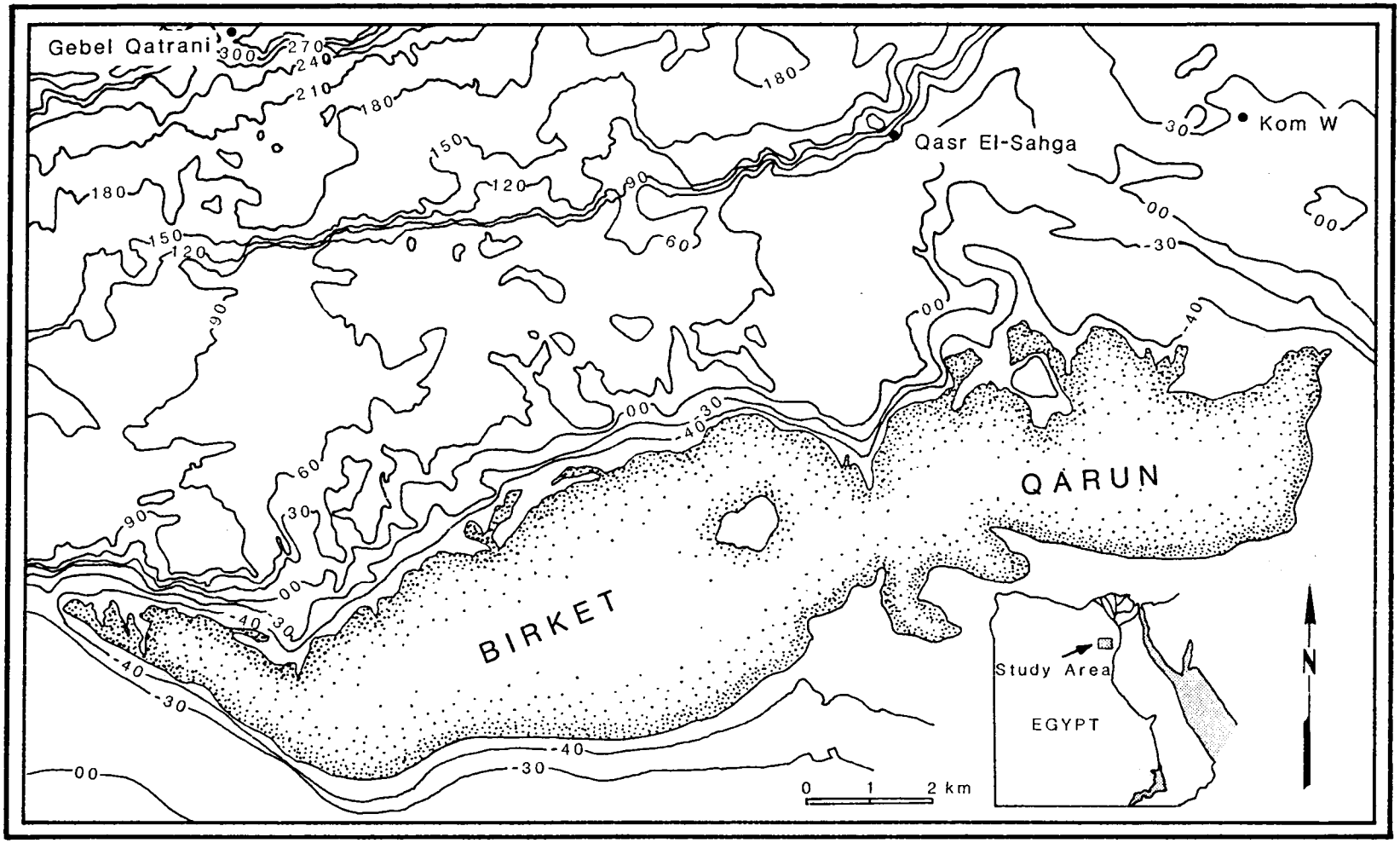


Figure 4. Map of the Fayum showing the location of Gebel Qatrani, the Old Kingdom temple of Qasr El-Sagha, and Kom W.

323-30 BC) who lowered the lake to reclaim the silt fan beyond the entrance to the Fayum Depression. The lake, deprived of the influx of water from the Nile, shrank through evaporation.

Archaeology

Evidence gathered by Wendorf and Schild (1976) and Wenke et al. (1983), supported by several radiocarbon dates, indicates that Fayum B sites are older than Fayum A sites and are associated with an earlier episode of lake transgression, contradicting Caton-Thompson and Gardner's earlier finds (Table 2). Nevertheless, all investigators agree upon the characteristics used to define and identify Fayum A and B cultural manifestations.

Terminal Paleolithic Fayum B assemblages share a number of technological and typological attributes and clearly cluster into a single industry named the Qarunian. The preferred raw material was rounded chert pebbles from the Oligocene conglomerate of nearby Gebel Qatrani (Mt. Qatrani) (Wendorf and Schild 1976); large outcrops are extensively exposed on the plateau above the Qasr el Sagha temple (Figure 4).

Cores recovered from the Qarunian assemblages were the simple platform variety and had no preparation except for the platform. The tool kit is dominated by backed blades and bladelets, which account for more than 50% of the lithic tools. Bone tools are also present but are uncommon; most are small projectile points manufactured from Silurid (catfish) spines. Double-pointed cylindrical bone points are also present (Wendorf and Schild 1976). The Qarunian lithic complex closely

Table 2. Radiocarbon dates (BP) from Fayum A and B sites.

Site	Date	Reference
	Fayum A	
I/79	5540 ± 70	Ginter et al. 1982
I/79	5555 ± 60	Ginter et al. 1982
I/79	5645 ± 55	Ginter et al. 1982
V/79	5990 ± 60	Ginter et al. 1982
V/79	6075 ± 50	Ginter et al. 1982
VID/80	5410 ± 110	Ginter et al. 1982
VIIA/80	5070 ± 110	Ginter et al. 1982
VIIA/80	5160 ± 120	Ginter et al. 1982
Kom K	5810 ± 100	Wendorf and Schild 1976
Site R	5860 ± 115	Wendorf and Schild 1976
Upper K	6095 ± 250	Libby 1955
Upper K	6391 ± 180	Libby 1955
FS-1	5160 ± 70	Wenke et al. 1983
	Fayum B	
FS-2	7720 ± 70	Wenke et al. 1983
FS-2	7600 ± 70	Wenke et al. 1983
FS-2	8220 ± 105	Wenke et al. 1983

resembles that of the Shamarkian (Kom Ombo) (Figure 5) and Hassan (1976, 1978), who has recovered several Terminal Paleolithic assemblages from the Western Desert, has noted that in some respects they closely parallel Qarunian Fayum B assemblages.

Traits characteristic of Neolithic economies have been documented from a large area of North Africa. Many of these assemblages have either been dated or are considered older than the earliest Neolithic sites in the Fayum (ca. 3910 BC) or the delta site of Merimda (ca. 4170 BC). These Neolithic traits, however, occur in assemblages that would in every other respect be considered Upper Paleolithic in character. Consequently, anyone involved in research who uses the term Neolithic must consider its meaning. Neolithic has been applied differently by prehistorians, thus its meaning has become ambiguous. These different applications of the term are important because they concern the criteria used to define Neolithic (Hays 1975).

Neolithic was first used by Sir John Lubbock to mean the "New Stone Age," which was characterized by ground and polished stone tools, bifacially flaked projectile points, pottery, farming, and stock breeding (Hays 1975). Some prehistorians, however, do not consider all these criteria before referring to an archaeological assemblage as Neolithic. For example, the presence of pottery and ground stone at the site of Early Kartoum (ca. 6000-4000 BC) caused it to be considered Neolithic, although there was no evidence of domestication (Arkell 1975, Balout 1965). The Sudanese Neolithic, consequently, not only contains Early Khartoum but also Shaneinab (ca. 3300 BC), which produced the remains of

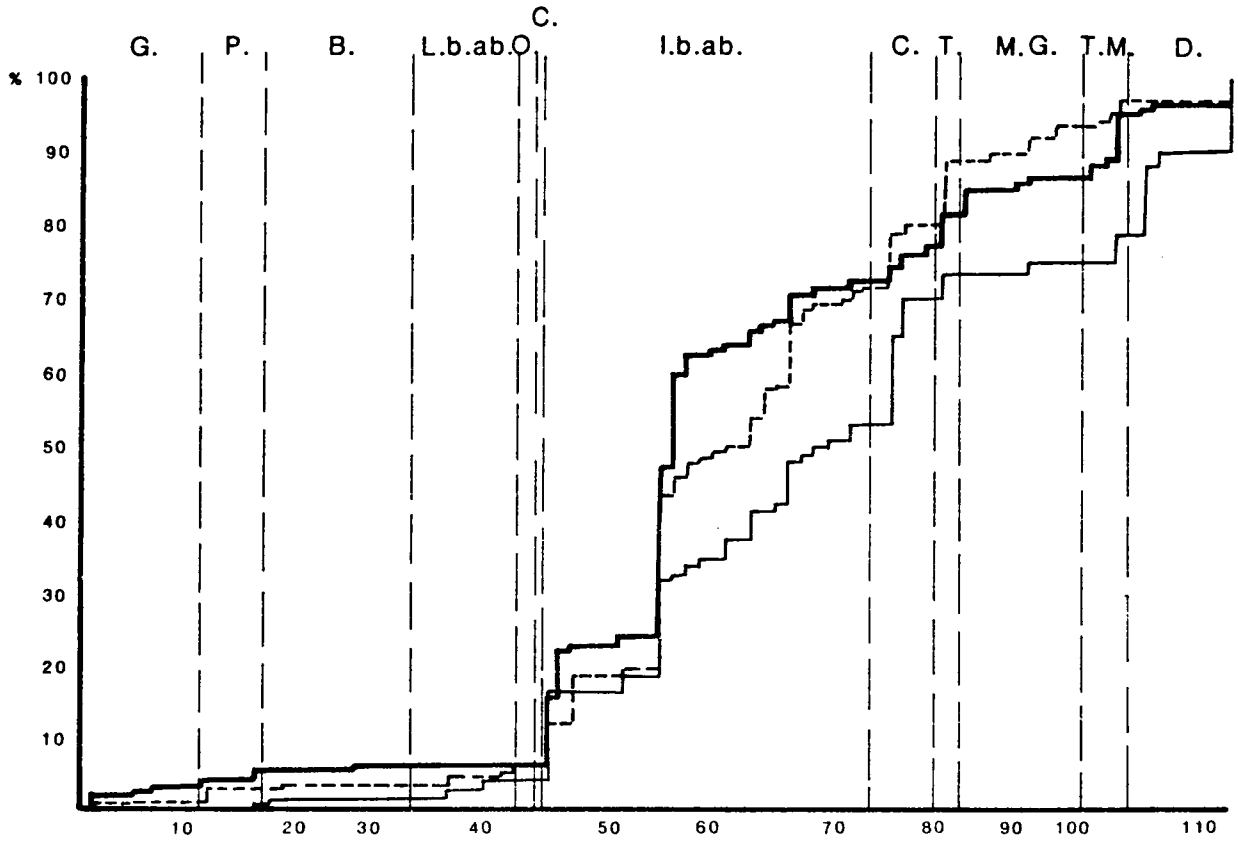


Figure 5. Cumulative graph of two Qarunian (Fayum B) lithic assemblages and one Shamarkian assemblage. G. = end scrapers, P. = perforators, B. = burins, L.b.ab. = backed flakes and blades, O.C. = composite tools, 1.b.ab. = backed bladelettes, C. = notched pieces, T. = truncations, M.G. = geometric microliths, T.M. = microburin technique, D. = divers (after Wendorf and Schild 1976 figure 210).

early domesticated goats. This combination can only serve to confuse the issue because the two sites had different stone tools, ceramics, and economies (Arkell 1953, 1975).

The position of this author concurs with the resolution passed at the 1965 Wenner-Gren African Symposium, which suggested that the term Neolithic be reserved only for those assemblages containing evidence of domestication. If this definition is used, one of the earliest undisputed dates for a Neolithic economy in Egypt comes from the Fayum (3910 ± 115 BC). Only the delta site at Merimda has produced an earlier date (ca. 4100 BC)(Butzer 1976).

In terms of lithic components, Neolithic tool assemblages from the Fayum appear to have no connection with the preceding Terminal Paleolithic. Lithic technology of Fayum A assemblages are based predominately on flakes produced by the hard-hammer technique. Bifacial tools made on thin tabular flint and stemmed and concave-based projectile points are common, but the backed blades and bladelets so common in the Terminal Paleolithic are absent in the Neolithic assemblages (Wendorf and Schild 1976).

A gap of about 1200 years separates the most recent Terminal Paleolithic site from the earliest Neolithic site. (Wendorf and Schild 1975). Wendorf and Schild (1976) believe that this hiatus is too short a period of time for development of a Fayum A lithic tool assemblage from a Fayum B technology. They believe the best explanation is the appearance of a new population in the Fayum area (Wendorf and Schild 1975).

Fayum Subsistence Practices: An Interpretive Model

Although research in the Fayum has served to substantiate that two cultural entities utilized Fayum resources, little evidence has been compiled pertaining to what resources were used and how changes in resource productivity might have affected Fayum inhabitants. One, of course, cannot hope to answer all the relevant questions regarding the disappearance of Fayum B and the subsequent appearance of Fayum A by the analysis of one resource locality, but a great deal of information can be gained and applied to several important questions.

The assumption that a group possessing a specialized resource base, had become established in a patchy desert environment shortly after the disappearance of a group possessing a generalized resource base, an assumption that contradicts current ecological theory, can be evaluated. Establishing dependence of each group upon Birket Qarun's natural resources, the duration and season of occupation, and the environmental mechanisms for cultural change will provide valuable information pertaining to this apparent contradiction of current theory (Figure 6).

Although molluscan remains have been used as indicators of Birket Qarun's past shorelines (i.e., Caton-Thompson and Gardner 1934) and faunal remains have been analyzed in conjunction with and as a by product of other research endeavors, no problem-oriented investigation based primarily on recovered faunal remains has ever been attempted in Egypt. Because so little is currently known about the functional aspects of Fayum lithic tool assemblages, the vast amount of faunal remains

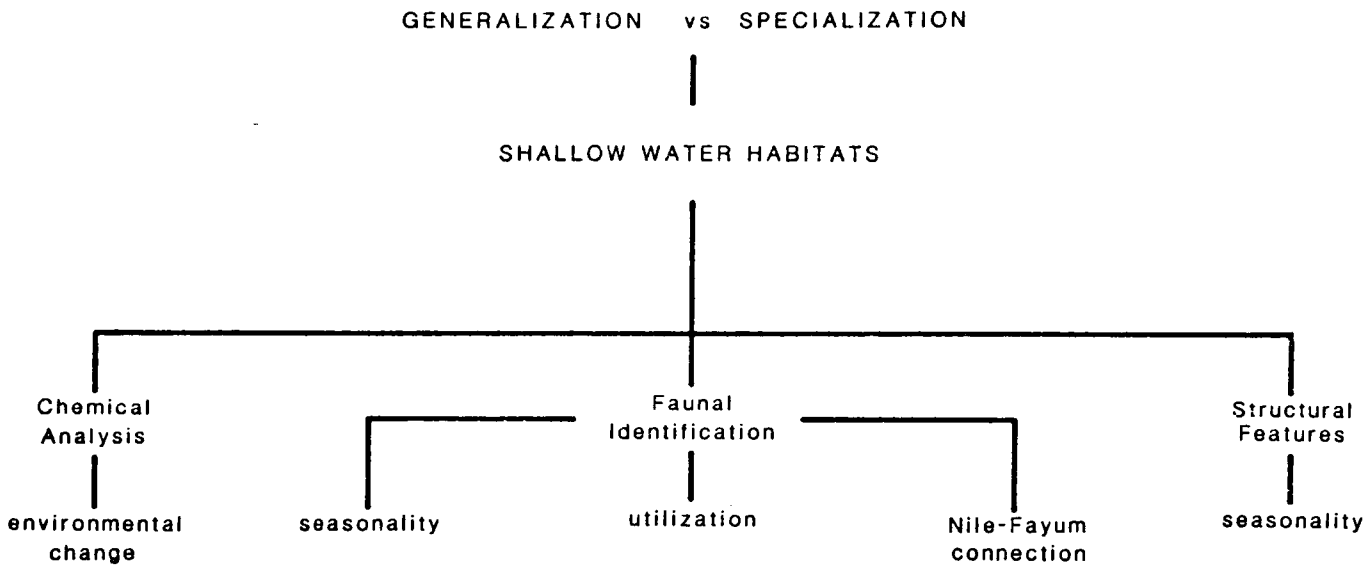


Figure 6. Flow sheet outlining goals of research project.

associated with both Fayum A and Fayum B cultural loci offer the most important evidence documenting cultural change in this area. The faunal remains provide a direct link to the prehistoric environment in which Fayum inhabitants lived and carried out their subsistence activities. The analysis of faunal remains can provide clues to related problems such as prcurement strategies, diet, and seasonality, as well as offer independent evidence to support or refute conclusions based on lithic and other standard forms of archaeological analysis.

Published information regarding faunal materials collected from previous Fayum expeditions (i.e., Caton-Thompson and Gardner 1934; Wendorf and Schild 1976; Wenke et al. 1983) has provided evidence that procurement strategies for mammals differed between Fayum A and B cultural assemblages. The Fayum A sites are dominated by the remains of domestic animals; the Terminal Paleolithic Fayum sites possess only the remains of wild game animals (Caton-Thompson and Gardner 1934; Gautier 1976). In a preliminary report, Wenke et al. (1983) record fish, predominantly catfish, as the most common animal represented in both Fayum A and B sites. Examination of the faunal assemblage by this author showed "catfish" of the genus Clarias as the most common animal represented. Clarias spp. prefer to live in shallow swampy water (Greenwood 1976; Greenwood and Todd 1970), and this suggests that Fayum inhabitants relied upon the shallow water resources of Birket Qarun.

An examination of topographic maps of the Fayum suggests that changes in lake depth would greatly influence the extent of land inundated by water (Figures 3, p. 17, and 7). Significant changes in lake

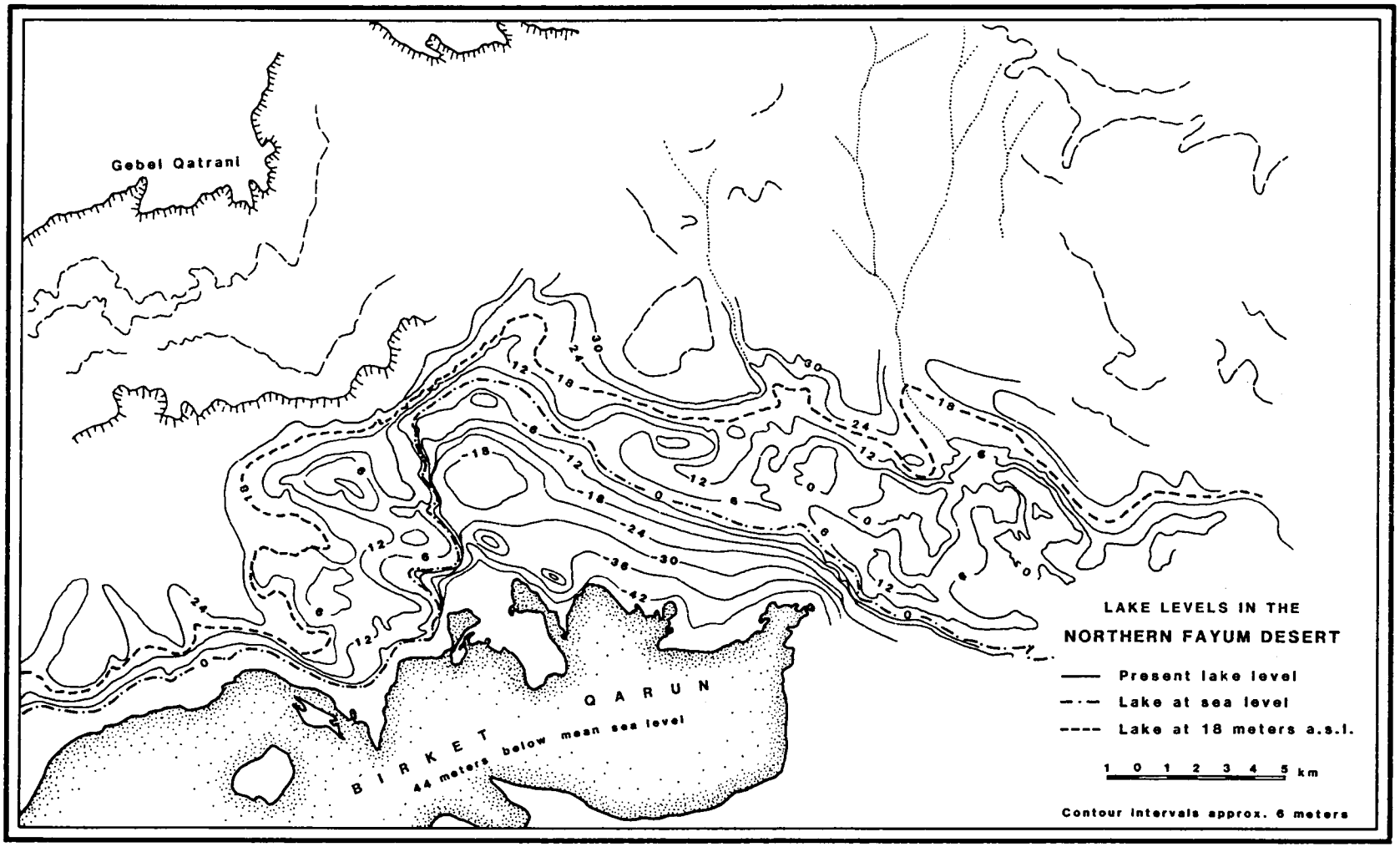


Figure 7. Northern Fayum Depression showing maximum extent of Premoeris Lake--+18m, extent of lake at sea level, and modern lake.

levels would consequently disrupt the plants and animals that had become established near the lake's shoreline. That is, the shallow water habitats providing cover and breeding areas for waterfowl and certain fish species would be destroyed if lake levels decreased significantly. Hassan (1985) has monitered lake level fluctuations and based on the modern day climate the lake level would decrease through evaporation about 1.8 m per year. Hassan further suggests that if the Nile flood stage dropped below the level of the Nile-Fayum divide (-17 m), the lake could dry up in as little as 100 years. Human populations dependent upon lake resources would then be faced with a crisis, necessitating a change in procurement strategies.

With time, the disrupted shallow water habitat could become re-established at a new lake level, but areas conducive to such habitats would also have decreased as the shores of the lake became more confined within the Fayum basin.

Testing this proposition requires that the use of shallow water habitats by Fayum inhabitants be demonstrated, that environmental changes significantly affected these habitats, and that those environmental changes elicited adaptive responses from those groups living in the Fayum Depression.

Exploitation of shallow water habitats can be demonstrated by the identification and analysis of faunal remains found in association with cultural assemblages identified as Fayum A or Fayum B (see Figure 6). Environmental change demonstrated through faunal analysis poses a more difficult problem. Geologic evidence gathered by Wendorf and Schild

(1976) on changes in lake and Nile River levels must be utilized as the basis for any argument attempting to show significant changes in lake level. However, species of fish identified from remains recovered in archaeological context can provide clues to the periodicity of the Nile-Birket Qarun connection, and isotopic analysis of fish elements can provide information concerning the effect of temperature on fluctuating lake levels.

Finally, the investigation of annual growth rings in Clarias pectoral fin spines and the presence of certain species of migratory waterfowl should provide clues as to seasonal procurement strategies and the duration of occupation of Birket Qarun during the year.

CHAPTER 2

ENVIRONMENTAL SETTING AND IMPLEMENTATION OF A ZOOARCHAEOLOGICAL SURVEY IN THE FAYUM DEPRESSION

The Study Area

The Fayum Depression is one of the major oases of the Western Desert. It covers an area of 12,000 square km, with a general slope towards the northwest where Birket Qarun is located. The Fayum, however, is usually looked upon as part of the Nile Valley rather than part of the Desert (Wendorf and Schild 1976). This is because the eastern boarder of the Fayum is located less than 15 km from the Nile and is connected to the Nile via the Bahr Yousef canal (Hawara Channel) (Wendorf and Schild 1976). This connection makes the Fayum unique among Western Desert depressions.

One of the earliest accounts of the Fayum comes from Herodotus around 450 BC. He described an artificial lake 3600 furlongs in circumference and 50 fathoms deep. According to Herodotus, water from the Nile flowed into the lake six months of the year and from the lake back into the Nile during the other six months. He referred to the water filled depression as Lake Moeris (Meinertzhagen 1930; Wendorf and Schild 1976).

Although Birket Qarun is not artificial, the possibility does exist that extensive hydrologic engineering conducted during the twelveth dynasty, possibly during the Reign of Amenemhat I (1991-1961 BC), deepened and widened the Hawara Channel allowing for a greater influx of

Nile River water. This allowed the level of the lake to rise 10 m above sea level, placing the lake and river in hydrologicic equilibrium (Issawi 1976). Engineering activities on the lake may have caused Herodotus to mistakenly believe Lake Moeris (Birket Qarun) was artificial.

Today Birket Qarun, which occupies the lowest part of the depression, is 44 m below sea level. The lake is bounded by a vertical scarp which extends in an arc around the north, west, and southern portion of the depression. The escarpment along the northern boundary of the Fayum Depression attains an elevation of 300 m above the depression floor (Figures 8, 9, and 10). The escarpment wall is nearly vertical possessing overhanging steps which vary in horizontal width from a few meters to almost a kilometer. A basalt sheet forms the top of the scarp (Issawi 1976). The western and southern scarps are much lower in height and are more dissected than the one to the north. The floor of the Fayum Depression rises gradually toward the adjacent scarps, forming undulating dissected pediplains covered by deflated sand. Protruding out of the sand are hard limestone knobs and patches, giving the area its characteristic type of landscape.

Fayum Geology

The physiology and geology of the depression were first extensively investigated by Beadnell (1905). He proposed that a series of tectonic movements accompanied by wind deflation during the Pliocene and Pleistocene accounted for the origin of the depression. Two decades

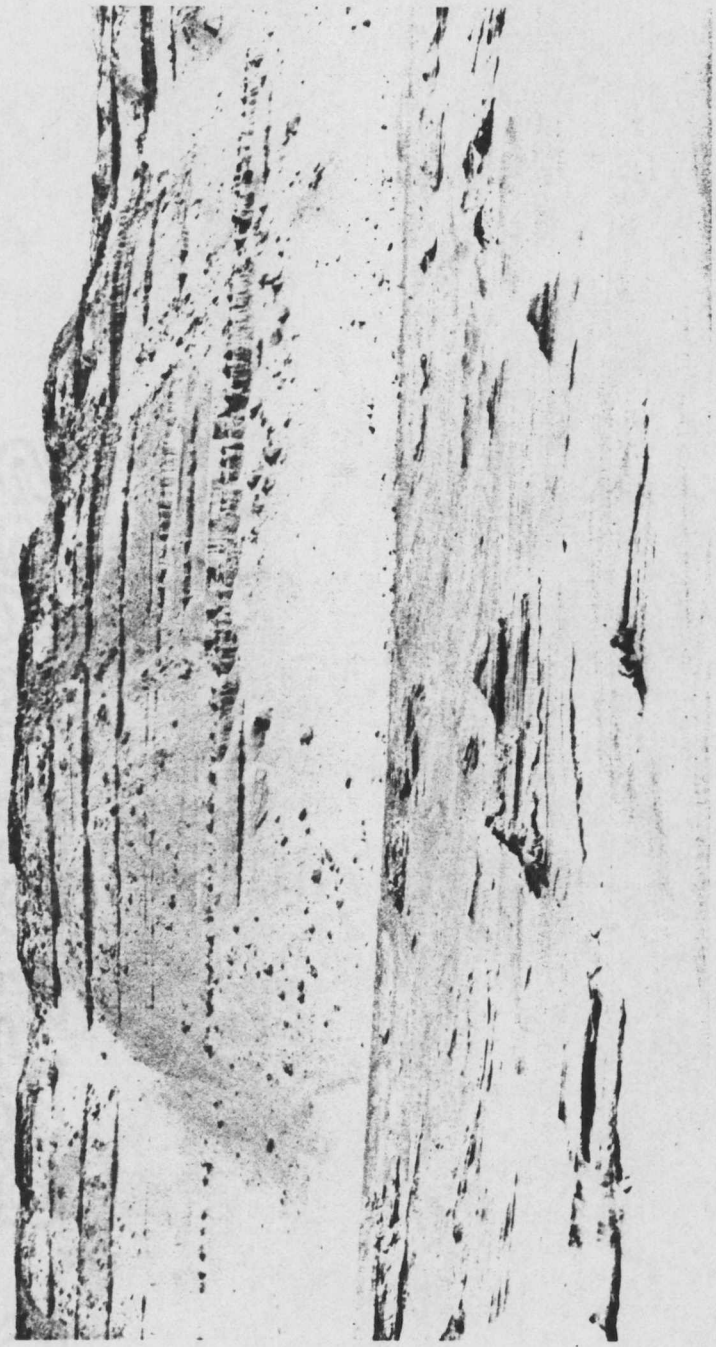


Figure 8. Escarpment along the northwestern boundary of the Fayum.



Figure 9. Escarpment along the northcentral boundary of the Fayum.

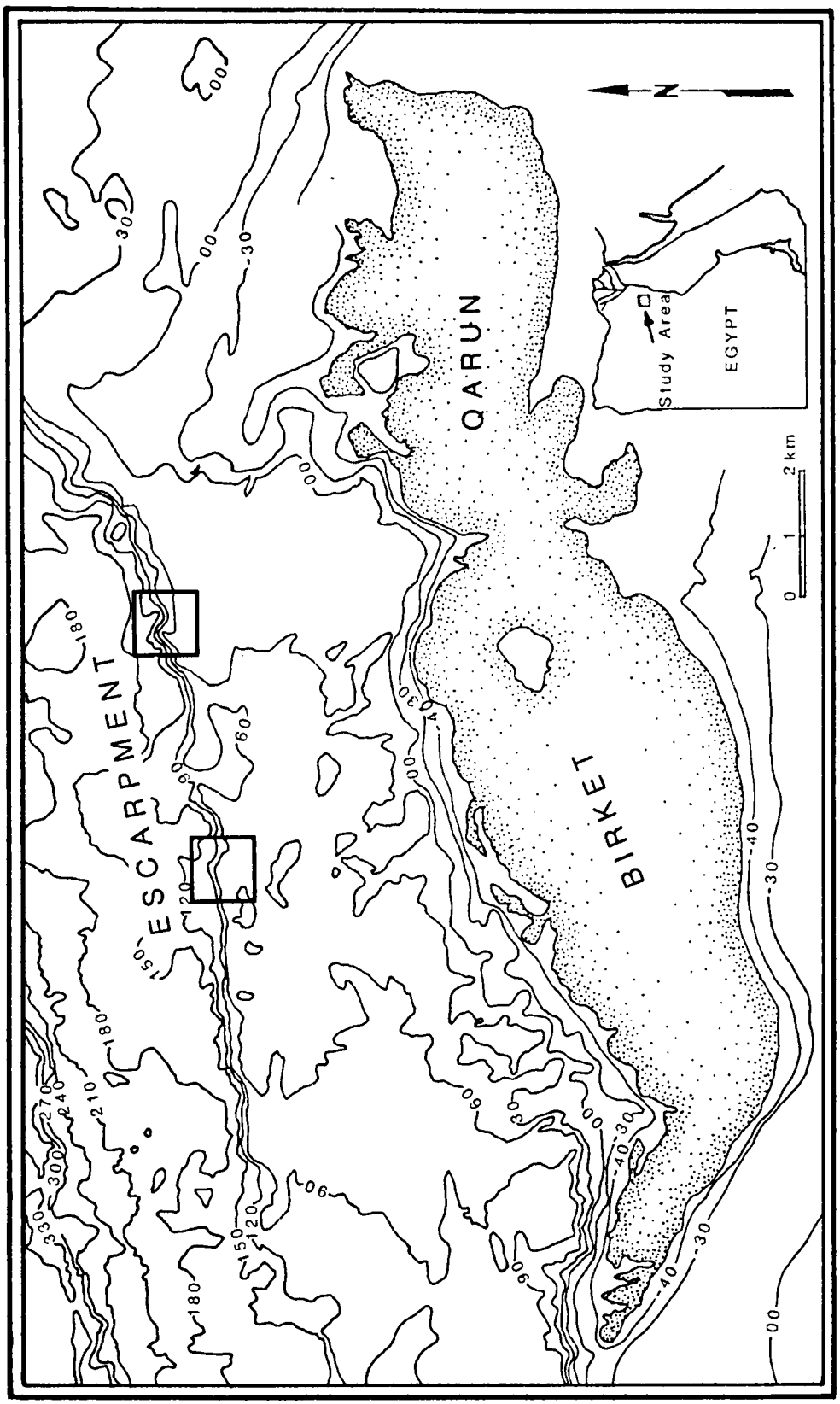


Figure 10. Map of the Fayum illustrating areas pictured in Figures 8 and 9.

later, Sanford and Arkell (1929) conducted a geological and archaeological survey along the Nile which included the Nile-Fayum divide. They determined that the Fayum Depression was formed as a result of fluvial erosion. Erosion they believed occurred up to pre-Mousterian times when water from the Nile was passing through the Hawara Channel to Lake Qarun.

These diverse interpretations of the origin of the Fayum Depression led the Geological Survey of Egypt to sink several test holes in the Hawara Channel to determine the depth of the bedrock sill separating the Nile from the Fayum. The results of this work showed the sill to be 17 m below sea level, thus indicating the depression which is less than -44 m could not have been formed by fluviatile action alone (Little 1936). Ball (1939) later proposed that the depression was hollowed out by wind deflation in early Pleistocene times. Recently, Issawi (1976) noted that the Fayum Depression is surrounded by a great number of faults, most of which trend northwest to southeast. Tectonic activity, possibly accompanied by wind deflation, appears to be the most likely explanation for the formation of the depression.

The stratigraphy of the Fayum was first presented by Beadnell (1905) and reviewed by Said (1962). The succession of sediments exposed at the Fayum are presented in Table 3.

Fayum Desert Features

Serir (pebble desert) (Figure 11) and Raml (sand desert) (Figure 12) are the main surface forms of the Fayum. Raml supports most of

Table 3. Succession of sediments exposed in the Fayum.

Quaternary deposits
Pliocene sandstone
Lower Miocene sand and gravel
Oligocene basalt
Gebel Qatrani Formation
Qasr El-Sagha Formation
Birket Qarun Formation--Upper Eocene
Wadi Rayan Formation--Middle Eocene

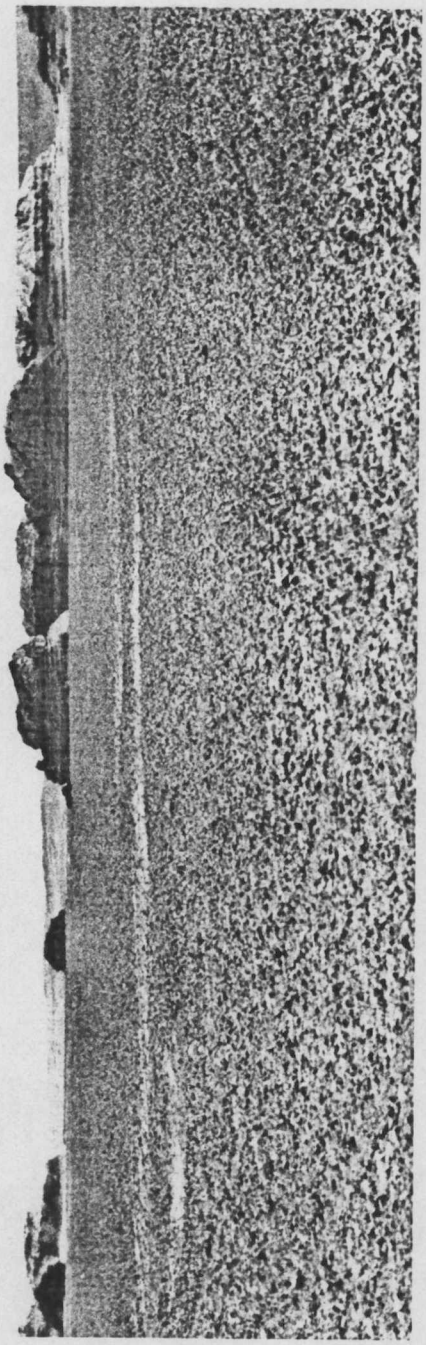


Figure 11. Serir or pebble desert.

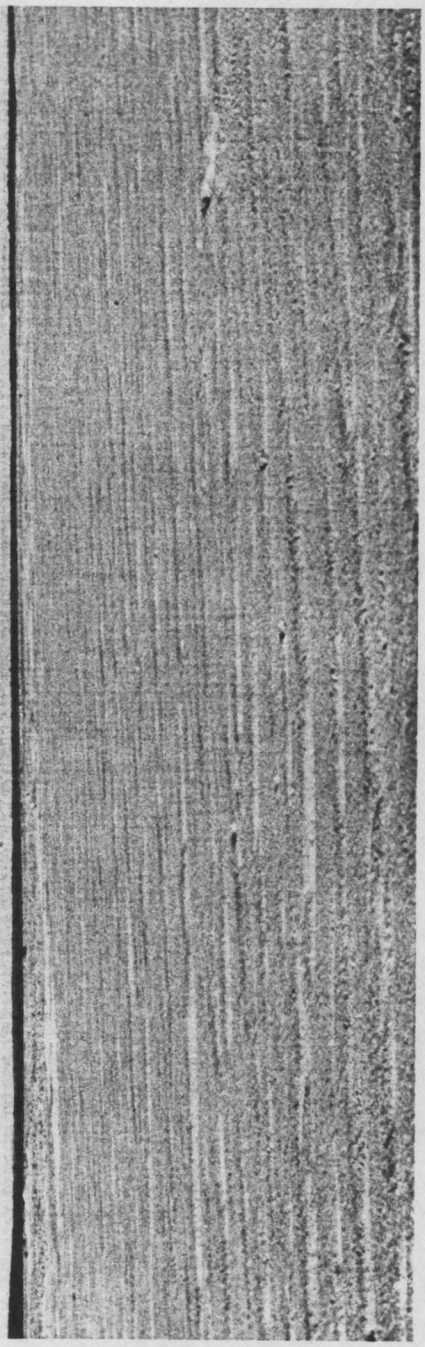


Figure 12. Raml or sand desert.

the vegetation in the area. According to Davis (1953) sand supports vegetation in areas that would otherwise be quite bare, acting as a mulch, and preventing the substrate from drying out. Serir is composed of small to large stones or cobbles. Temperature extremes cause fracturing of solid materials from which all the finer sand and dust have been blown away, leaving only a stone veneer overlying hard packed sand (Hume 1921; Kassas 1952). A mature serir consists of angular, faceted pebbles polished smooth by wind and sand. Because plants and animals cannot become established on such surfaces, serir plains remain barren of vegetation. Some authors such as Zohary (1944) and Ranck (1968) classify serir under the term hamada. Hamada is defined as a desert characterized by a pebble to cobble stone surface.

Two desert features which commonly occur in the Fayum but are not dominant in terms of overall physiography are Nafash and Sebakha. Nafash is a powdery limestone or gypsum with a covering of pebbles or limestone fragments. Nafash is rarely vegetated and most difficult to traverse. Sebakha or saltpan is composed of a mixture of sand, salt, and, at times, water. Sebakha may overlie solid ground or salty sludge. When the latter condition prevails it is referred to in English as quicksand and the area is impossible to traverse. Fortunately, Fayum sebakha overlies solid ground.

The last major desert feature that deserves comment is the wadi. Wadi refers to a gully, canyon, valley, or any dry stream bed that conveys water at irregular intervals. A wadi is formed as the result of periodic erosion and deposition due to fluvial action. The bed of the

wadi is lower than the surrounding terrain and receives soil and water via complexly branched tributaries from an extensive drainage area (Kassas 1953). Because of the torrential nature of the water supply, as little as one centimeter of rain can cause flooding (Davis 1953). Consequently, main wadi channels within the mountains or plateaus are generally devoid of vegetation. Plants usually become established on terraces boardering the channel or on islands within broad channels. On plains where the rate of stream flow is negligible, plants may become established in the wadi bed. Some closed depressions such as Wadi el Rayan and Wadi Natroum are erroneously referred to as wadis.

Climatic Factors

Egyptian deserts are among the most arid regions of the world. Their air temperatures are among the highest and rain and relative humidity among the lowest of all African and Asian Deserts (Magahid and Abd el Rahmann 1953). Strong desert winds in combination with seasonally irregular and meager rainfall also help to desiccate the area. Deserts north of the city of Qasier (Figure 13), which includes the Fayum, are classified as temperate because the mean temperature of the coldest month falls below 18 degrees celsius. South of Qasier the deserts are considered tropical.

Annual rainfall in Egypt varies from a maximum of 200 mm near Alexandria to less than 1 mm at Siwa (Figure 13). The Fayum receives about 16 mm of rainfall per year. Rains can be expected from November to April, with the highest probability for rain occurring in December and

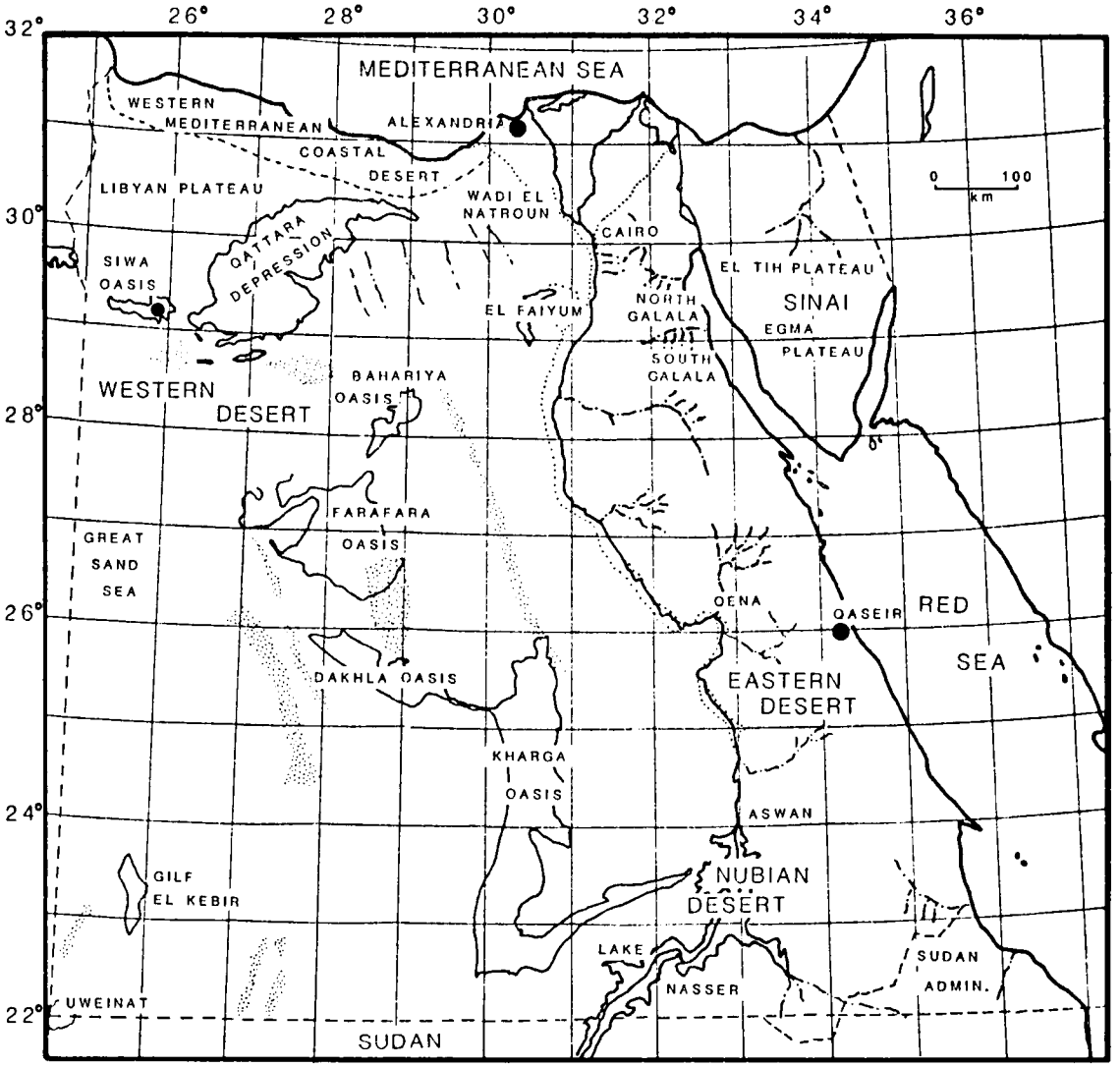


Figure 13. Map showing location of the city of Qaseir, Alexandria, and Siwa Oasis.

January, the coldest months of the year (cf. Osborn and Helmy 1980). Annual precipitation varies from zero to a series of cloud bursts. Years of low rainfall are usually followed by several seasons of higher rainfall (El Danasori 1957). The prevailing winds over most of Egypt are from the north. From March until May, winds known as Khamsin (50 day winds) produce severe sand storms. The winds, while they tend to scatter sand, do not affect the stability of the dunes (Ball 1927). The duration of a Khamsin is usually two to three days, sometimes recurring every two to three days (Osborn and Helmy 1980).

Vegetation

Prevailing high temperatures in combination with low rainfall and strong winds impose severe restrictions on desert plant life, producing shifting and tenuous populations (cf. Osborn and Helmy 1980). Areas of low relief such as plateaus and south facing cliffs are the least likely to support vegetation. North facing slopes of otherwise barren mountains may support a lichen flora because of subtle microclimatic differences (Abd El Rahmann and Batahouy 1966).

Water is the single most important factor for desert life (Louw and Seely 1982, Osborn and Helmy 1980) and desert plants have evolved numerous adaptations for conserving water and reducing transpiration (Osborn and Helmy 1980). The Fayum, like most Egyptian deserts, is classified as a runoff desert. In run off deserts, vegetation is confined mainly to channels and catchments of drainage systems, while rain deserts, in

contrast, receive enough rainfall to maintain a continuous vegetation cover.

Desert vegetation has been classified into three basic subdivisions; accidental, ephemeral, and perennial and are associated with accidental, ephemeral, and perennial water sources (Kassas 1966; Kassas and Girgis 1964). Ephemerals, although they may germinate accidentaly anywhere, are most abundant where rainfall is a certainty (i.e., Eastern Desert, Sinai, and the Coastal Desert). Perennials are found wherever there is the meagerest amount of moisture, provided there are suitable soils where water can accumulate. Although groves of Acacia trees (Acacia raddiana) occur in shallow basins throughout Egypt's Western Desert, no native stands of Acacia presently grow in the Fayum. Prehistorically, however, trees, perhaps Acacia trees, must have occurred in the area because around Birket Qarun's former shorelines are numerous large pieces of petrified wood (personal observation). Today the Fayum is in general void of vegetation, although a few sheltered areas do support a meager perennial flora.

Data Collection

The Fayum Depression offered an excellent opportunity to collect a large amount of information without the great expense of time usually required for such endeavors. Prevailing desert winds had covered prehistoric cultural remains with eolian sediments, preserving them. Winds later removed much of the sand and silt leaving behind a well preserved record of prehistoric cultural material, at times still partially imbedded in lake shore sediments.

In order to locate artifact concentrations suitable for study, it was first necessary to establish criteria which would have influenced the procurement and settlement strategies of the early Fayum inhabitants. Changes in the water level of Birket Qarun offered the most probable cause for shifts in settlement strategies. Consequently, a transect survey cutting perpedicular to the present shoreline offered the highest probability of crossing the greatest number of former ecological zones that surrounded the lake at different times in its history. It was believed that surveys based on such a strategy would be most likely to encounter faunal assemblages accumulated during different episodes of lake transgression. The fauna, in association with cultural artifact types, could provide information as to the kinds of taxa that had been utilized as well as clues to interpreting past environments.

The survey was limited to the north side of the lake, as the south side is under heavy cultivation and the western region of the depression had already been intensively collected by researchers from a previous expedition (Fayum Archaeological Project 1980) (Figure 14). Because of rough terrain, the survey was conducted on foot as well as from four wheel drive vehicles. As it turned out, artifact distribution was quite predictable. Artifact concentrations were located along former beach ridges with large areas of land between detectable prehistoric shoreline features void of faunal or cultural remains. Cultural artifacts and faunal remains were always found in association. Where there were faunal remains there were always cultural remains. On one occasion, fauna associated with cultural artifacts, located on a former stretch of lake shoreline, showed evidence of sorting (by size) and erosion. Wave

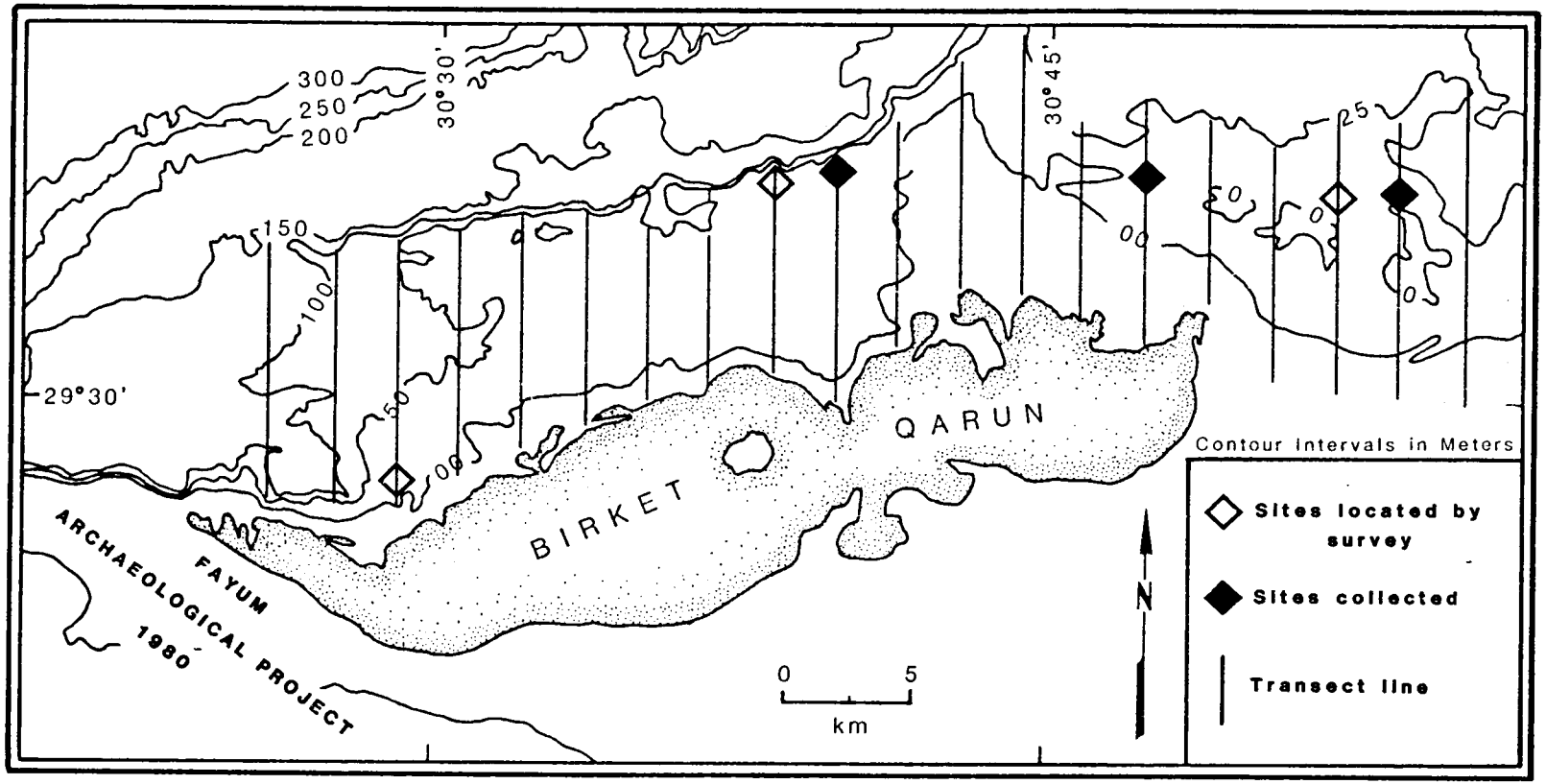


Figure 14. Map of Fayum Depression showing transect lines and region collected by the Fayum Archaeological Project 1980.

action was determined to be the most probable explanation for this condition. Consequently, because of the effects of sorting, the area was considered unsuitable for this study. In all, six concentrations of cultural materials were identified as suitable for possible study.

Large concentrations of cultural material were referred to as sites and were ranked on the basis of several criteria. First, and most importantly, sites were ranked as to the amount of faunal material that could be recovered for analysis. Second, sufficient diagnostic artifacts had to be present so that the accumulated material could be attributed to either Fayum A or B cultural activities. Using this criteria three cultural assemblages, two Fayum A and one Fayum B, were chosen for investigation. Additionally, faunal materials recovered from two sites investigated by other research teams was also incorporated into this study.

Data Recovery

Collecting surface remains posed a number of technical and methodological problems. To begin with a representative sample of the site's faunal remains had to be gathered in such a manner as to include detailed information on provenience and any artifact associations that might exist.

The first step involved defining the boundaries of each site. Site boundries were easily distinguished by an abrupt decline in cultural materials. Once the limits of the site had been established, a datum point for mapping was chosen and the site was surveyed in five meter transects running perpendicular to the former shoreline (Figure 15). It

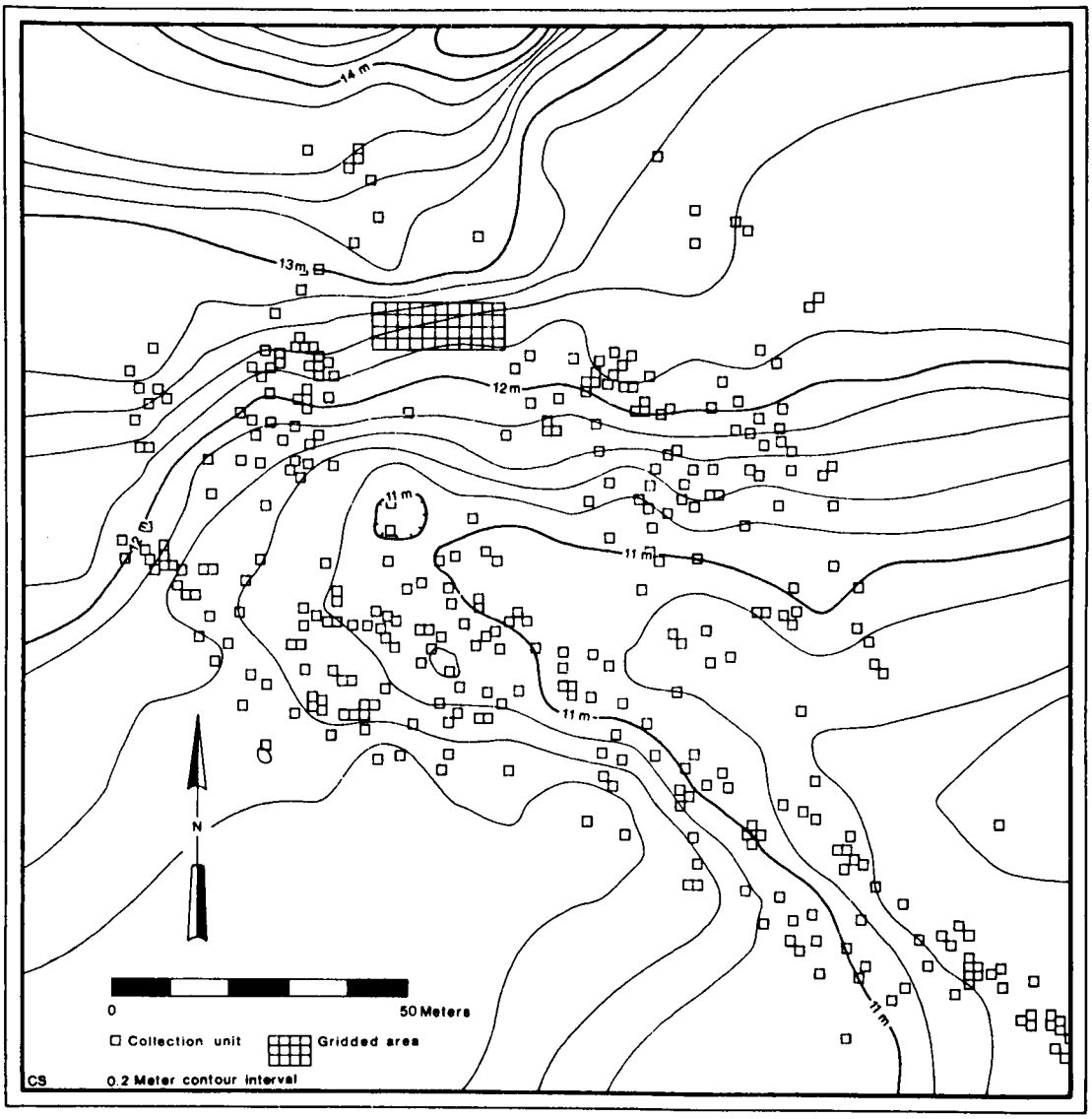


Figure 15. Map of Site 2 (Fayum A) showing collection units and gridded area demarking area of high bone concentration.

was thought that an increment of five meters offered a good view of artifacts without requiring frequent moves off the transect line to inspect materials.

When a bone deposit was identified, a survey pin was placed in the ground to mark the spot. Once the entire site had been surveyed and all the bones marked, the positions of the bones were recorded, using a distomat. Faunal remains found on the surface within a two meter area of the survey pin were collected. In areas where artifact densities were too high for such an approach to work effectively, the boundaries of the high density area were marked and the area was gridded in two by two meter units and collected (Figure 15).

Once the provenience of a bone had been recorded and the caked sand and lake sediments cleaned away, it was often necessary to coat the element with a thin layer of polyurethane glue before moving it. This was particularly useful when dealing with mandibles and long bones that were found partially imbedded in surface sediments and would have broken into unidentifiable pieces if moved without treatment. Once the glue had dried, the element was removed from the sediments and another thin coat of glue applied. Before the second coat dried, the element was wrapped in cotton. The cotton acted as a soft-cast protecting the bone from sudden jarring movements that were experienced all too frequently while traveling through the desert by motorized vehicle. Once in the laboratory, the cotton could be easily removed by hand and the fibrous residue quickly removed by passing the element over a candle flame.

Representativeness of the zooarchaeological sample was determined by redundancy. If, after the initial survey, it could be demonstrated

that continued sampling from each respective site would not add a significant number of new species to the data already gathered, it was concluded that common taxa were adequately represented in the sample (Figure 16; also see Wolff 1975). To demonstrate this point, the taxa recovered from Site 1 (Fayum A) and Site 2 (Fayum B) were plotted on cumulative curve diagrams (Figure 17). This example shows that once a point of redundancy has been reached continued sampling, while increasing the chances for the recovery of uncommon taxa, mainly serves to add elements from taxa that have already been identified. Because the goal of the survey was to collect data concerning population parameters of the site's faunal component and evidence based upon cumulative curves support the premise that common taxa were adequately recovered, the assemblage was considered to be representative.

Biases toward the recovery of larger faunal elements were checked by systematic fine screening of surface sediments along the transect line. Two collection units (2 m^2) were randomly chosen from each transect line for screening. If no significant difference existed between the screened and sight survey material, bias of this type would be considered negligible. This test, applied to Fayum collection units, showed no identifiable elements to have been missed from any screen tested unit. Color contrasts between the dark subfossil material and the light colored surface sediments are no doubt responsible for such a high incidence of recovery. Nevertheless, complete recovery of all faunal elements along any given transect line is highly improbable. The method of survey employed in this study undoubtedly introduced some bias towards the collection of larger faunal elements.

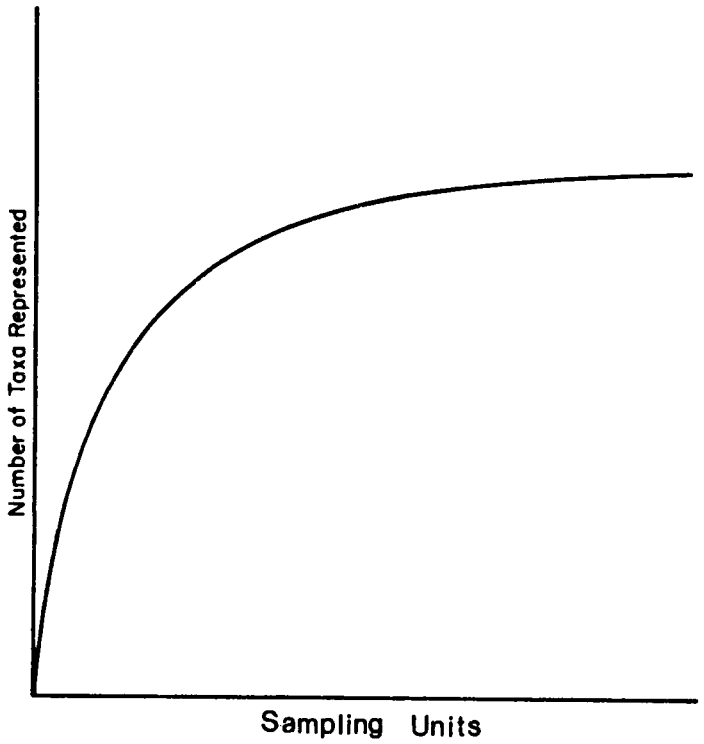


Figure 16. Representativeness of a zooarchaeological sample expressed on a cumulative curve diagram. The curve plotted rises steeply at first and then levels off. This reflects the fact that common taxa are detected before rare taxa are first encountered. A point is reached where continued sampling provides few or no new species. The sample can then be considered representative.

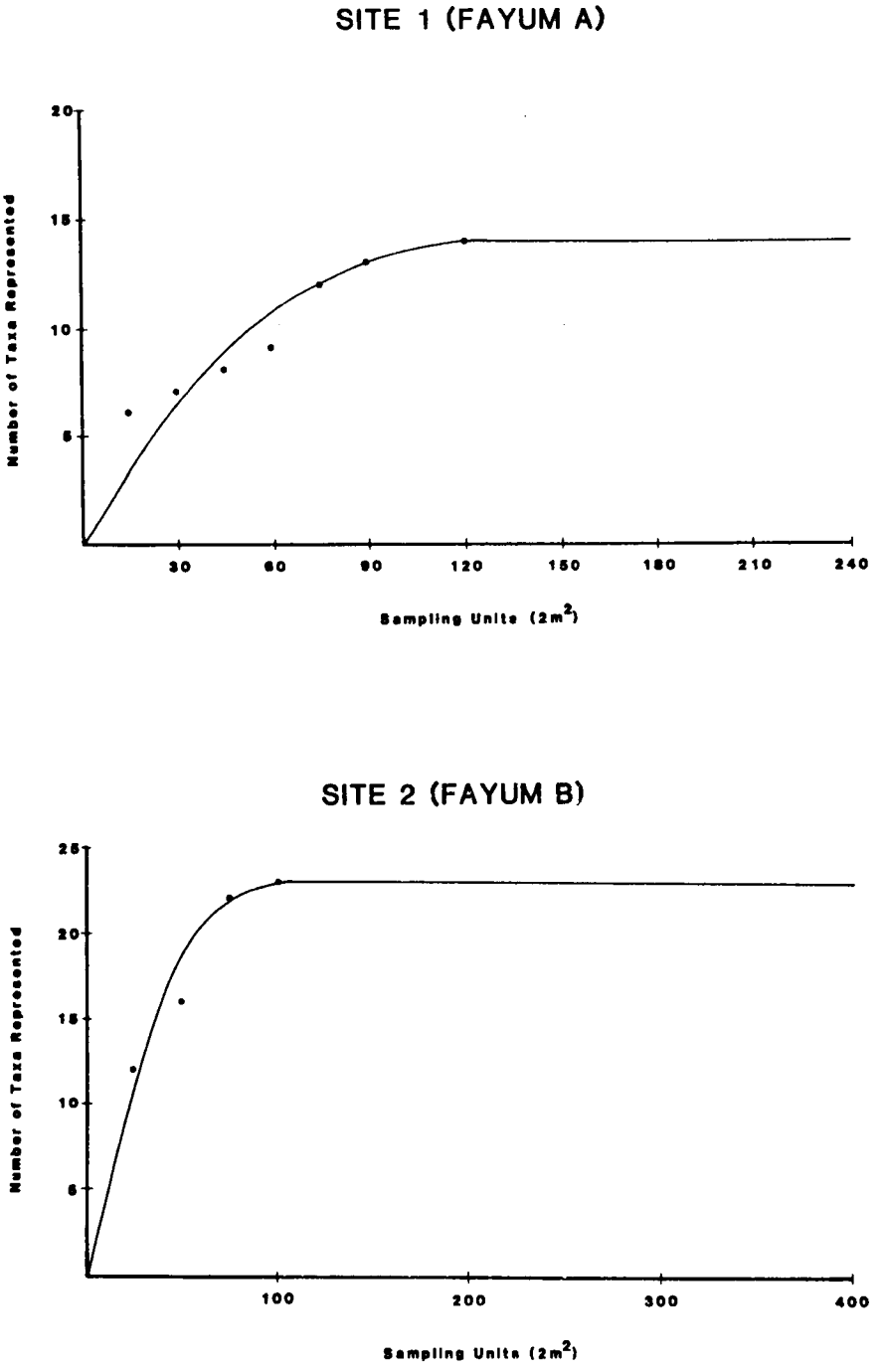


Figure 17. Cumulative curves based on fauna identified from Site 1 (Fayum A) and Site 2 (Fayum B).

Strong arguments do exist against the use of data based on materials collected from the surface deposits. Some archaeologists view surface data as totally useless (e.g., Clewlow 1968; Hole and Hiezer 1973), while others see the use of surface materials in a limited capacity, using such data only as a means for predicting subsurface deposits (e.g., Binford et al. 1970; Redman and Watson 1970; Ruppe 1966). Most objections to a surface collection as a source for analysis center on the lateral movement of artifacts due to postdepositional disturbances. Dunnell and Dancey (1983), however, have noted that with relatively few exceptions subsurface deposits originate as surficial ones and have been subjected to the same disruptive processes. In addition, subsurface deposits are influenced by the processes of deposition as well. Nonetheless, criticisms concerning lateral disturbances are of little consequence when an area is to be sampled for the purpose of attaining estimates on population parameters. Consequently, the use of surface finds for the purpose of delimiting the faunal resources utilized by Fayum inhabitants is justified.

Site 1

Site 1 (Figures 18, 19, 20, and 21) is located about 1.2 kilometers southwest of the Old Kingdom temple of Qasr El-Sagha and just immediately west of a stone-capped L-shaped mound. Several prominent remnant buttes of lacustrine sediments dot the area around the site. Caton-Thompson and Gardner (1934) visited this area and referred to the cultural locality as site R, but made little note of the materials found there. Wendorf and Schild (1976) revisited the site (E29G3) in 1969 and

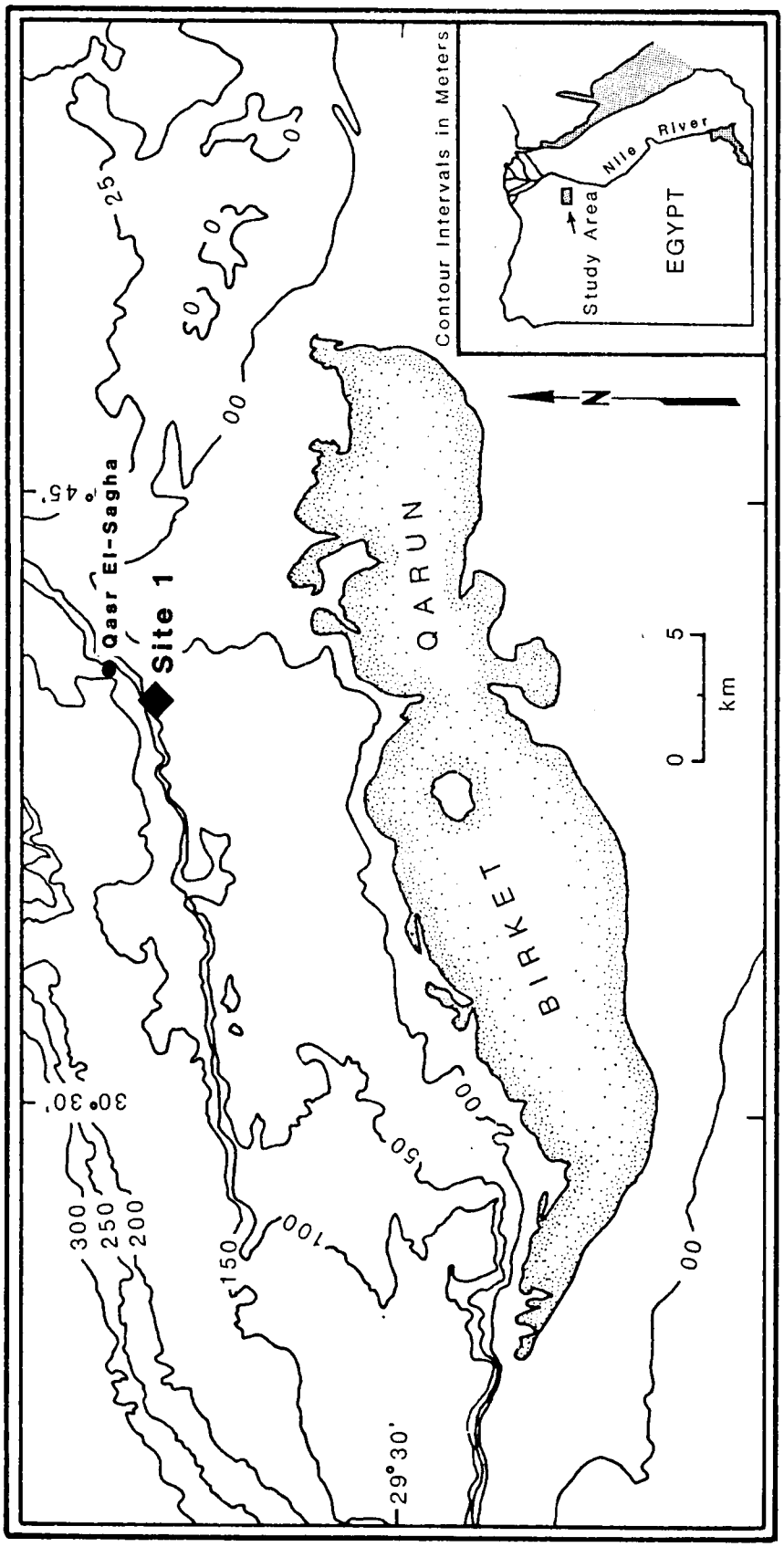


Figure 18. Map showing location of Site 1.

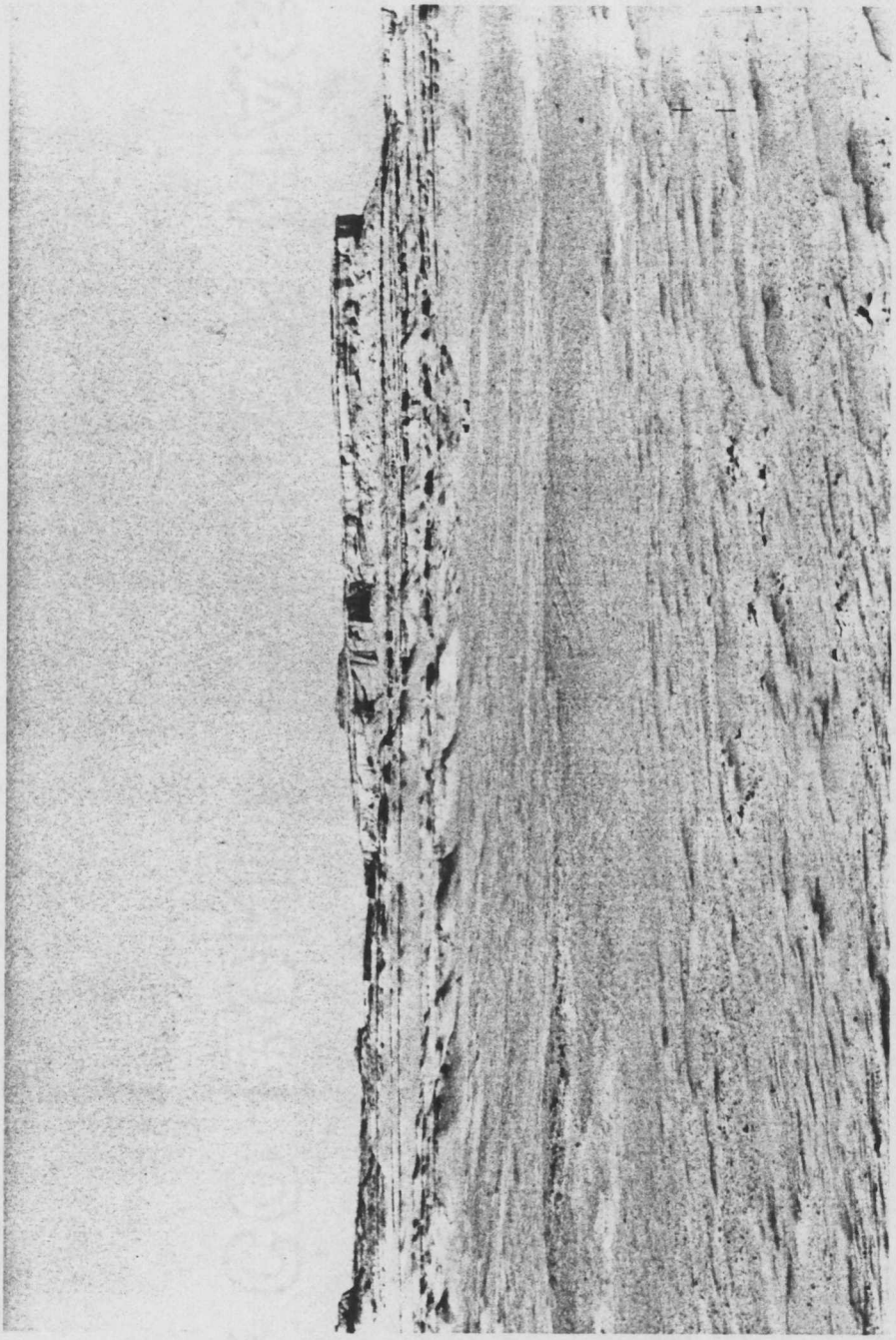


Figure 19. Site 1 looking north.

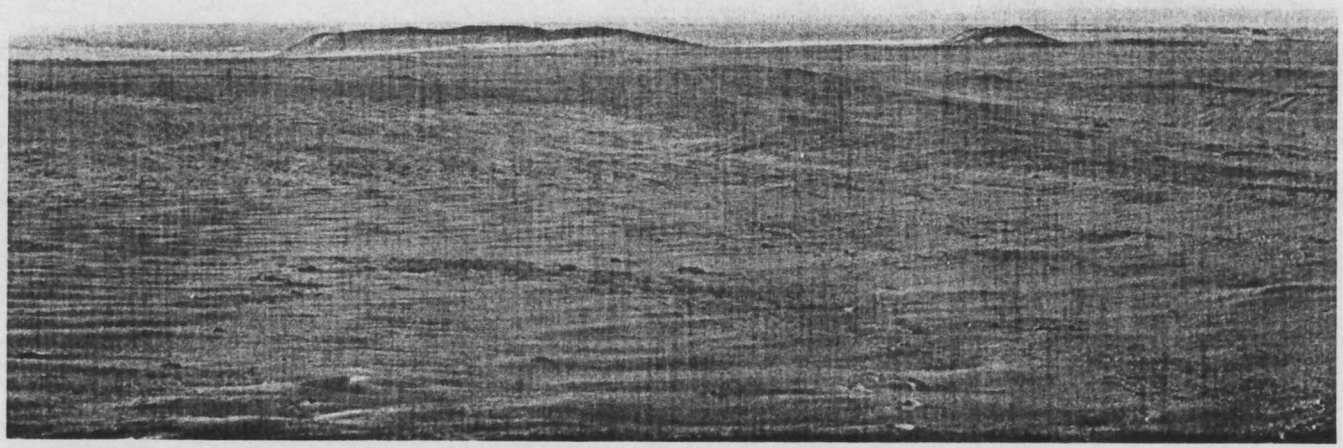


Figure 20. Site 1 viewed from the north.

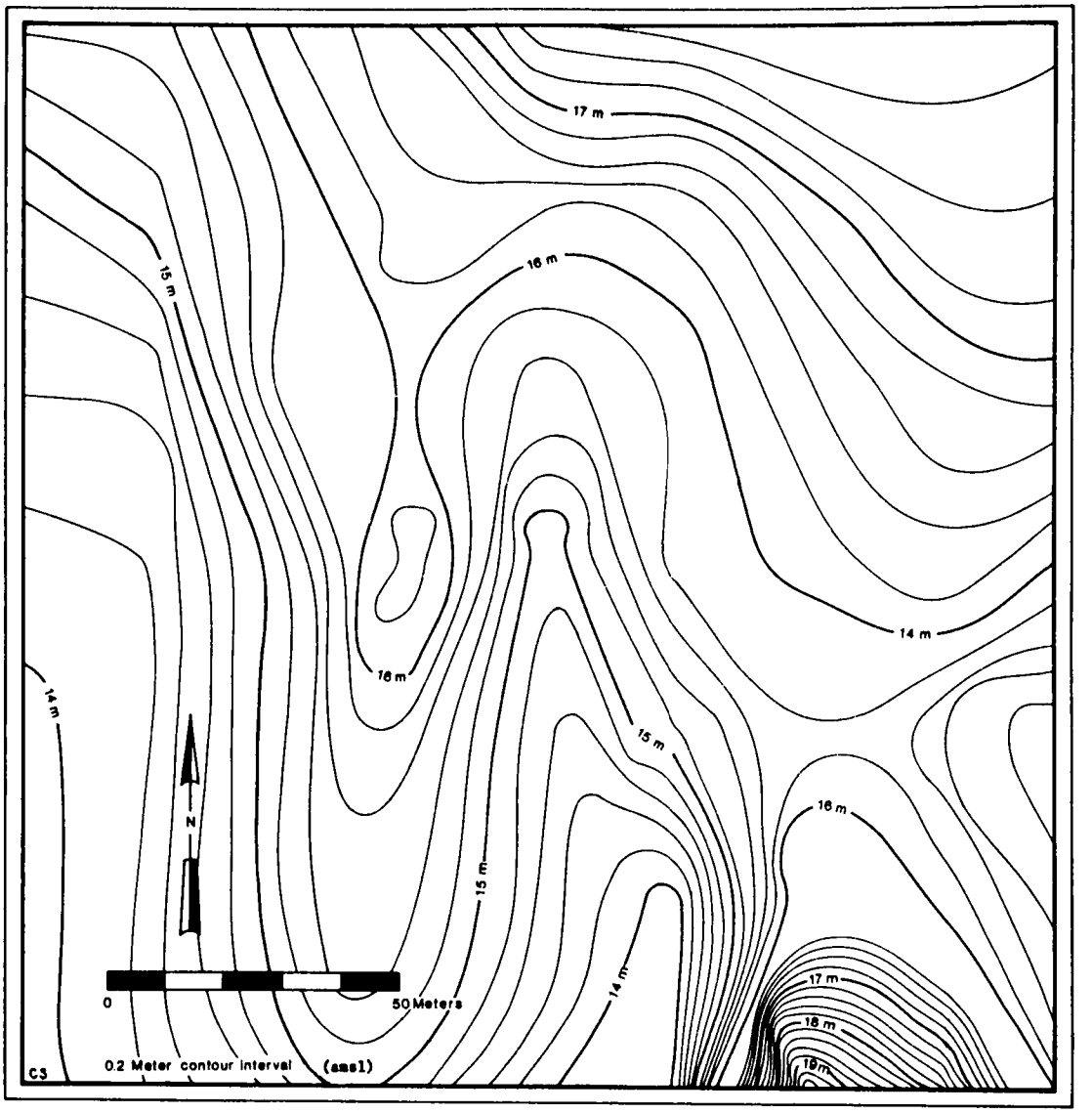


Figure 21. Contour map of Site 1.

did some extensive trenching on the south side of the stone-capped buttes.

Wendorf and Schild (1976) noted that the pottery from this locality was similar but not identical to that recovered from the type Fayum A site, Kom W. Fiber tempered pottery was not dominant at this site, as it was at Kom W. Many of the vessels from Site R (Site 1) were sand tempered and the sherds indicate that they had come from smaller vessels. Lithic artifacts included bifacial tools and concave-based projectile points. Recovered faunal remains included domestic animals. These artifacts are all characteristic of Fayum A assemblages and the site was so classified.

Wendorf and Schild (1976) did not intensively collect faunal remains from the north side of the stone capped buttes and because they had radiocarbon dated the Fayum A assemblage to 3910 ± 115 BC, it seemed appropriate to collect samples from the area to the north of the buttes.

Site 2

Site 2 (Figures 22, 23, 24, and 25) is located approximately 7 kilometers east of Kasr el-Sagha. Neither Caton-Thompson and Gardner (1934) nor Wendorf and Schild (1976) make any reference to this cultural assemblage. The area produced backed blades and bladeletts as well as long double-pointed bone points. No evidence of pottery, bifacially worked lithic tools, or other material characteristics of Fayum A culture were recovered from within the site boundaries. Site 2 produced the largest number of identifiable faunal elements collected by any Fayum expedition. No element was determined as having come from a

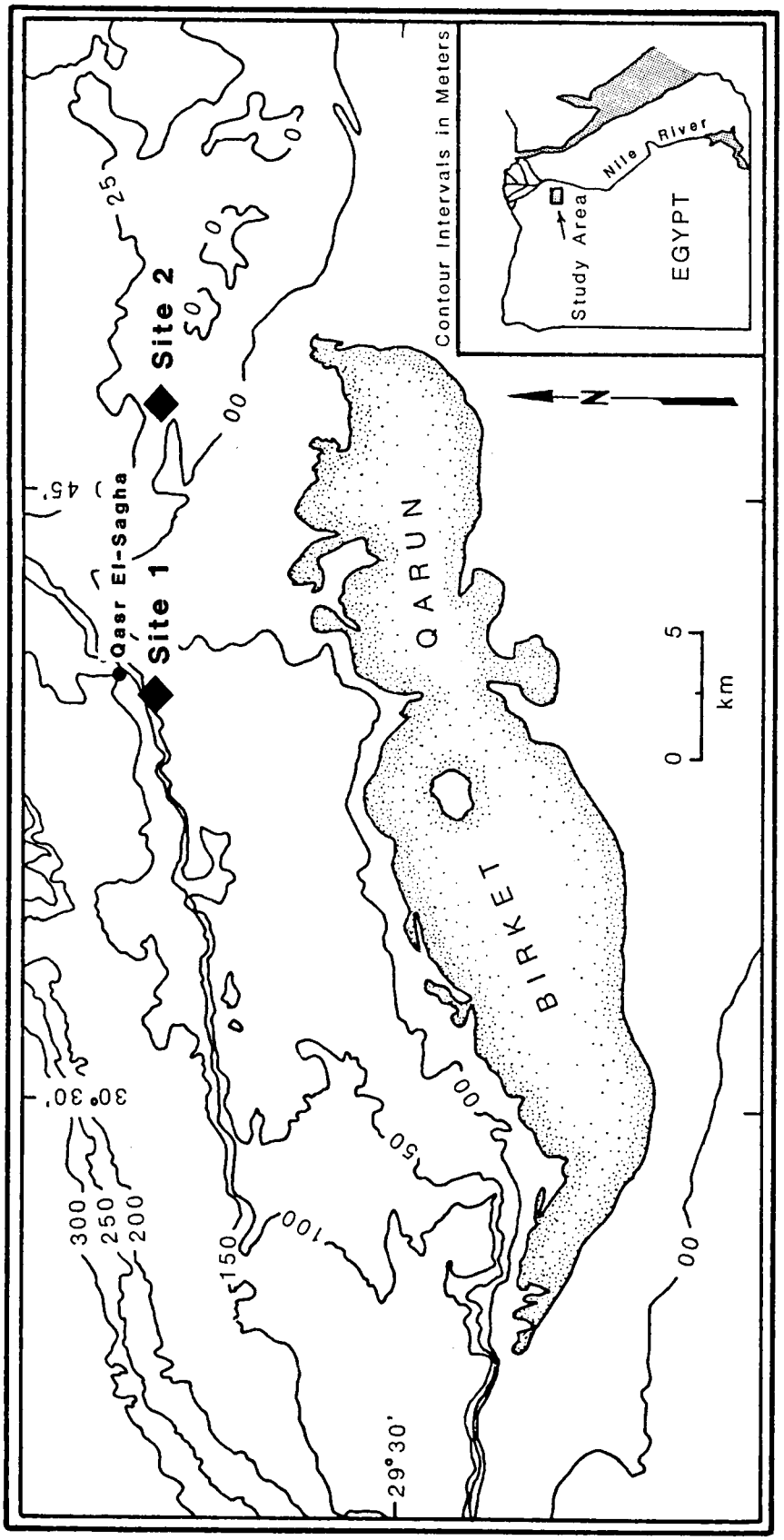


Figure 22. Map showing location of Site 2.

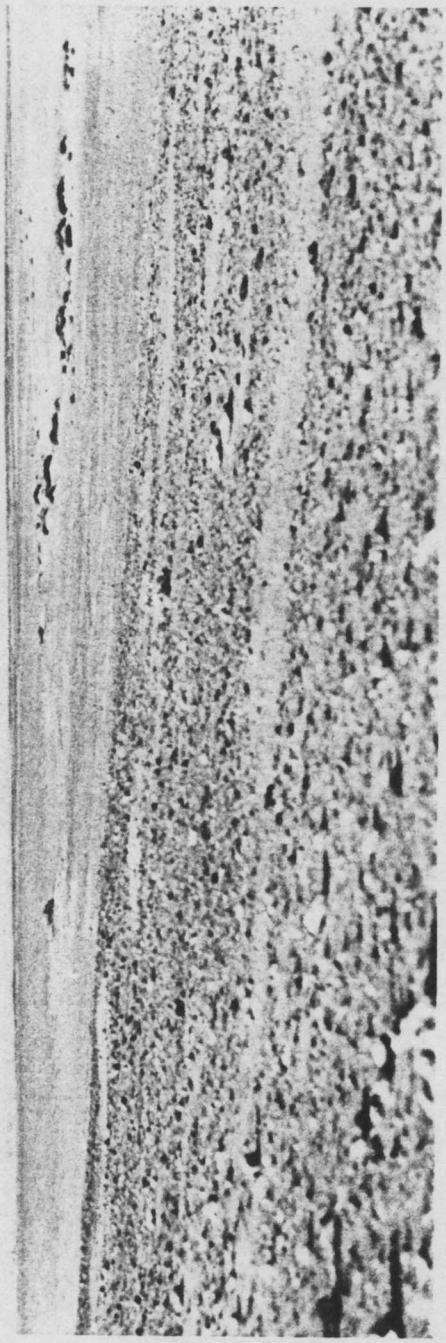


Figure 23. Site 2 looking north.

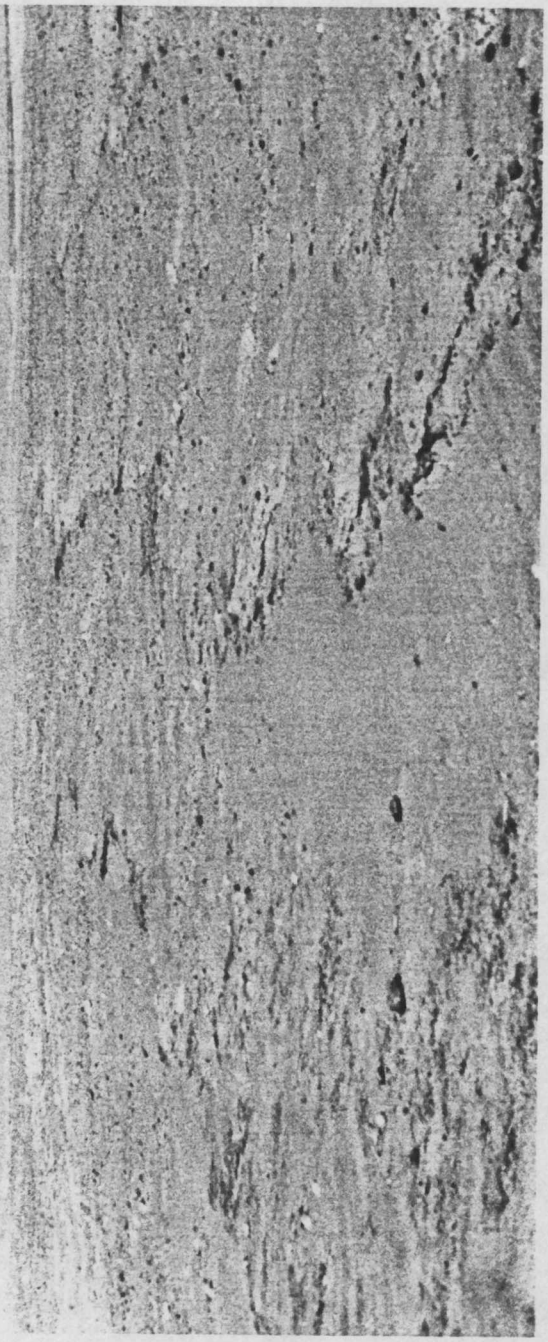


Figure 24. Site 2 looking east.

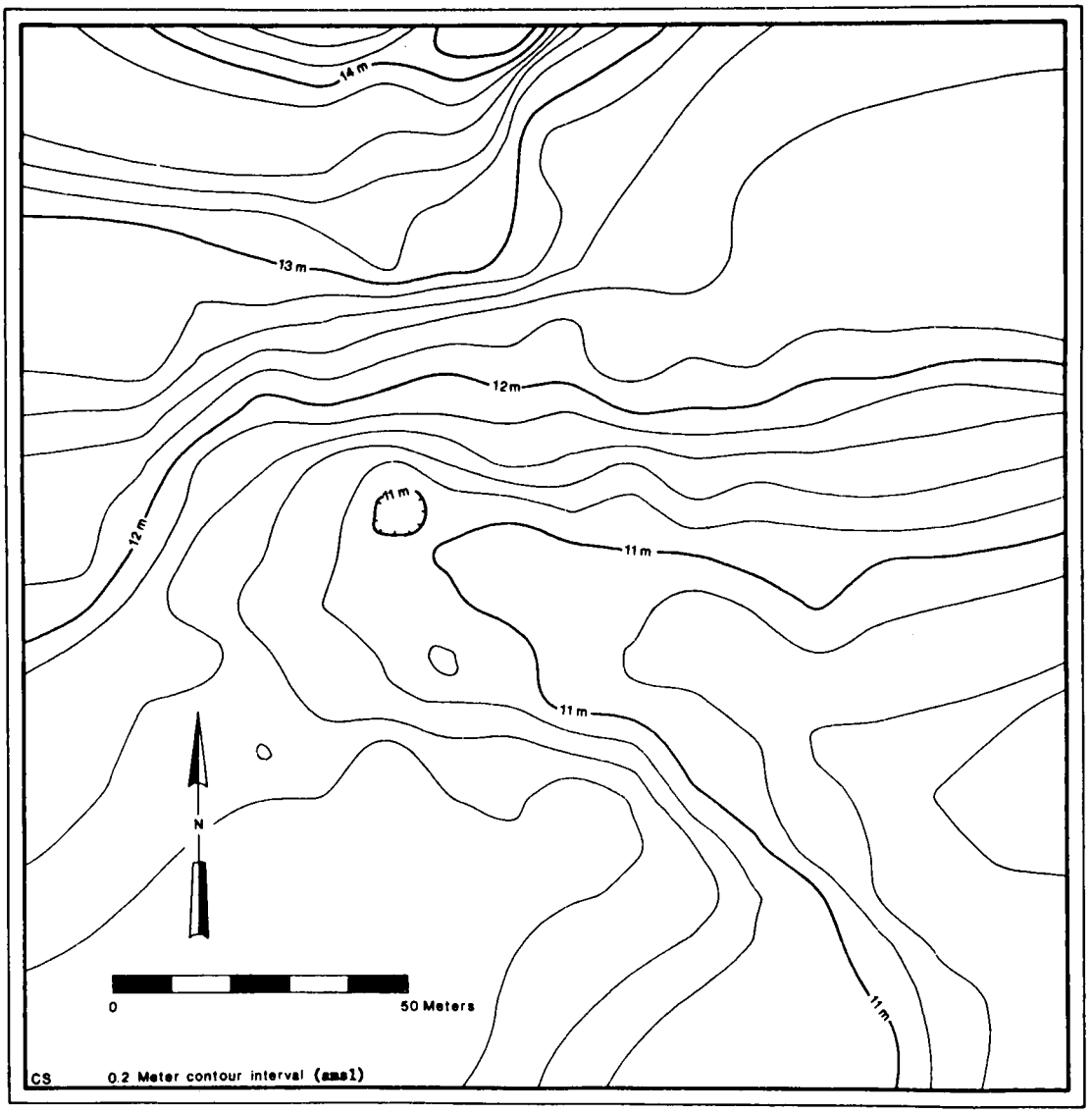


Figure 25. Contour map of Site 2.

domesticate. All characteristics of this site conform closely to known Fayum B cultural assemblages and, consequently, Site 2 was classified as Fayum B.

Site 3

Site 3 (Figures 26, 27, 28, and 29) is located approximately 21 kilometers east of Kasr el-Sagha. No reference to this site is made by Caton-Thompson and Gardner (1934) nor Wendorf and Schild (1976). It was originally thought because of the site's elevation and the apparent lack of large mammal remains that this area might be attributed to a Fayum B occupation. However, its potential contribution to the research project was considered of lesser importance than that of Site 2. This area was consequently assigned to a lesser status, to be collected only if time permitted. Due to a series of fortuitous circumstances regarding the labor force alotted to Site 2, there was sufficient time to allow for the collection of this cultural assemblage. As it turned out, Site 3 produced a lithic assemblage comprised of artifacts characteristic of Fayum A complexes, and it was so classified.

Site 4

Caton-Thompson and Gardner referred to this locality as Site T. It is approximately 2.2 kilometers southwest of Kasr el-Sagha and about 0.9 kilometers due west of Site 1 (Figure 30). Investigations at Site 4 were conducted by Paul Buck of the University of Washington. Buck (personal communication 1984) classified this site as Fayum A. No photographs or site maps are available for this area. However, the fauna recovered

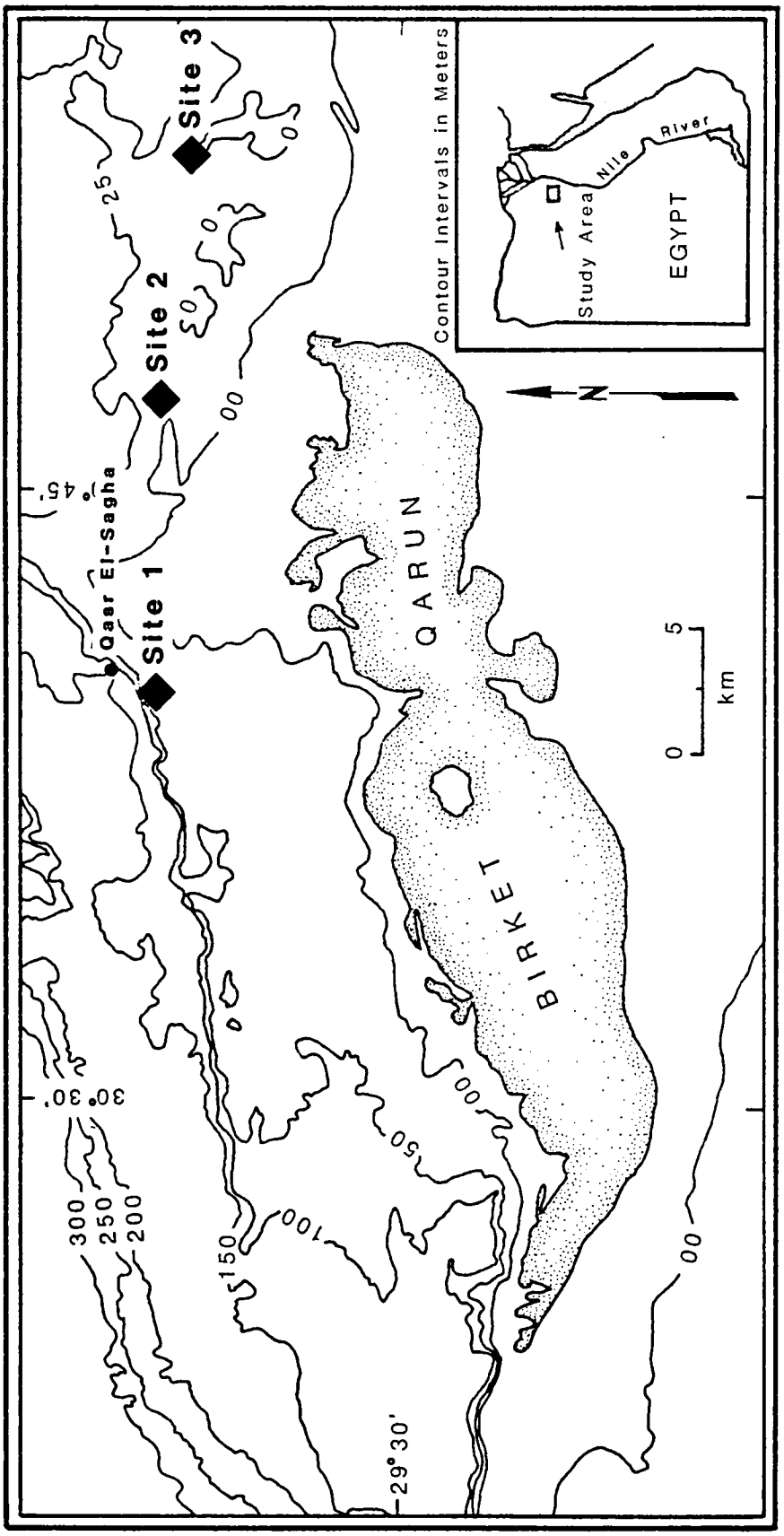


Figure 26. Map showing location of Site 3 in relation to Sites 1 and 2.

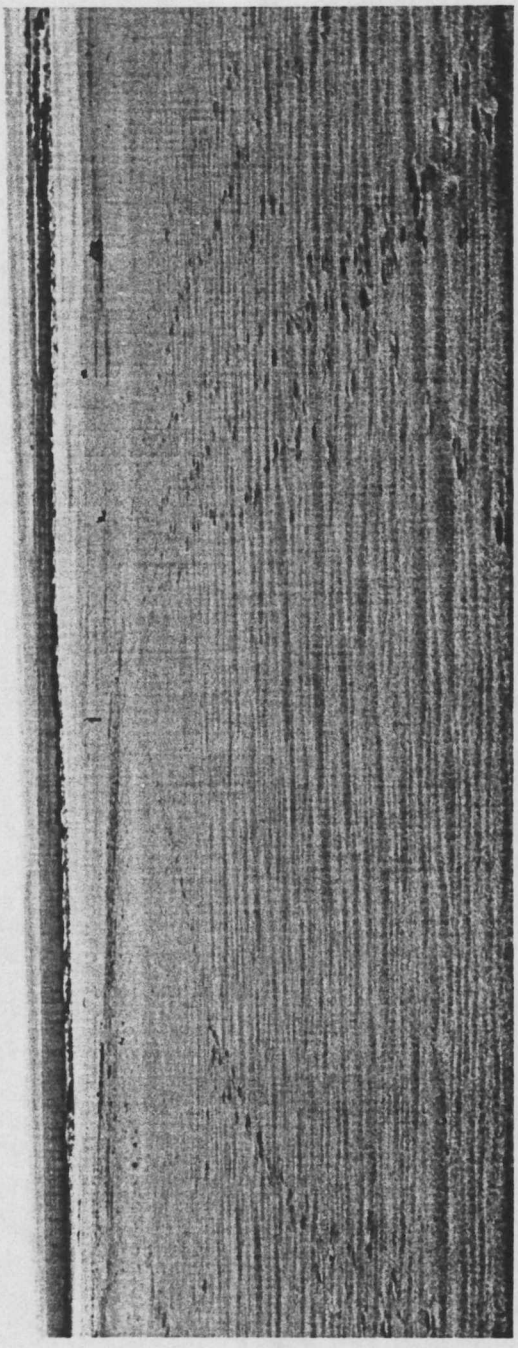


Figure 27. Site 3 looking south.



Figure 28. Site 3 looking east.

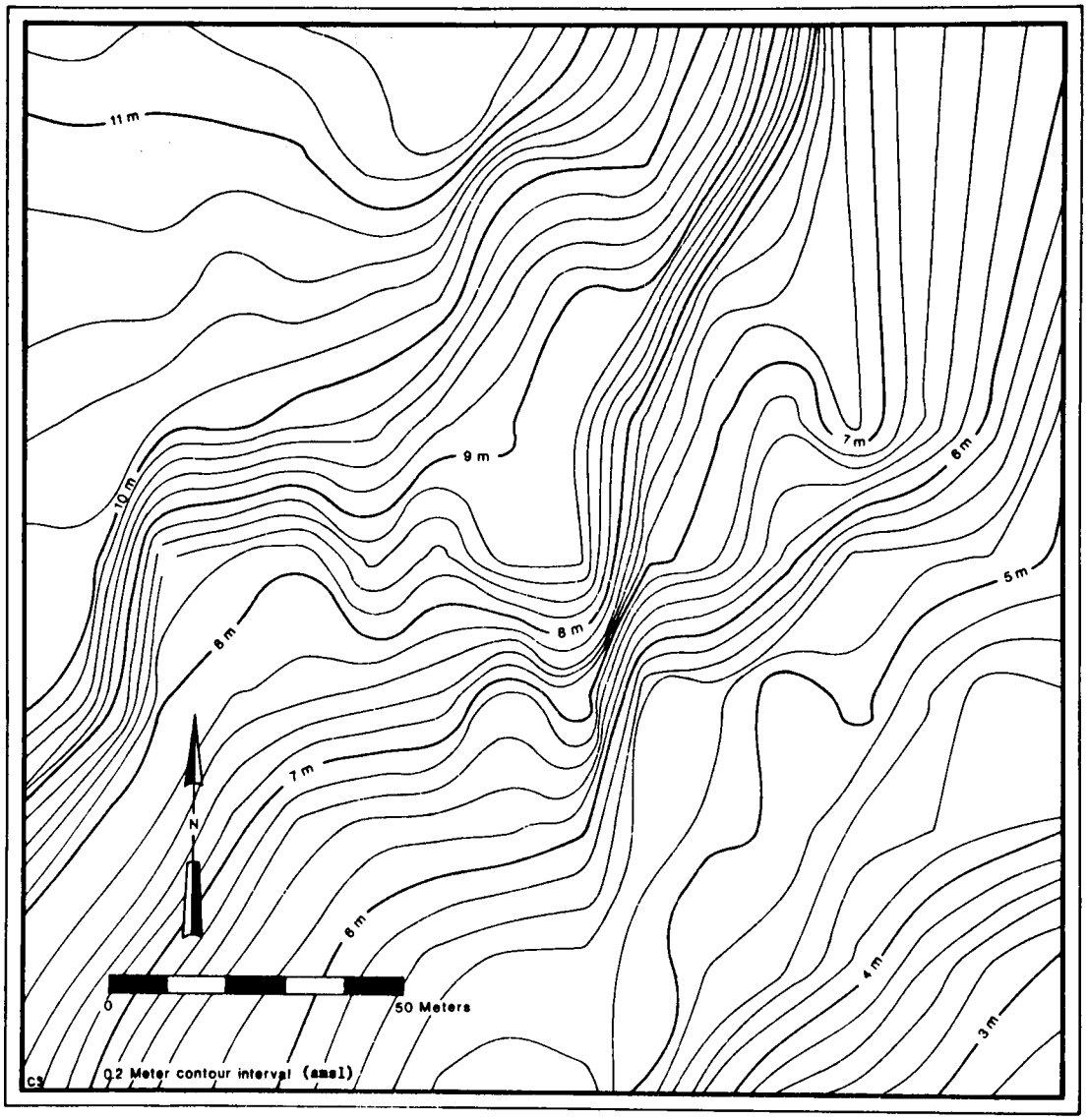


Figure 29. Contour map of Site 3.

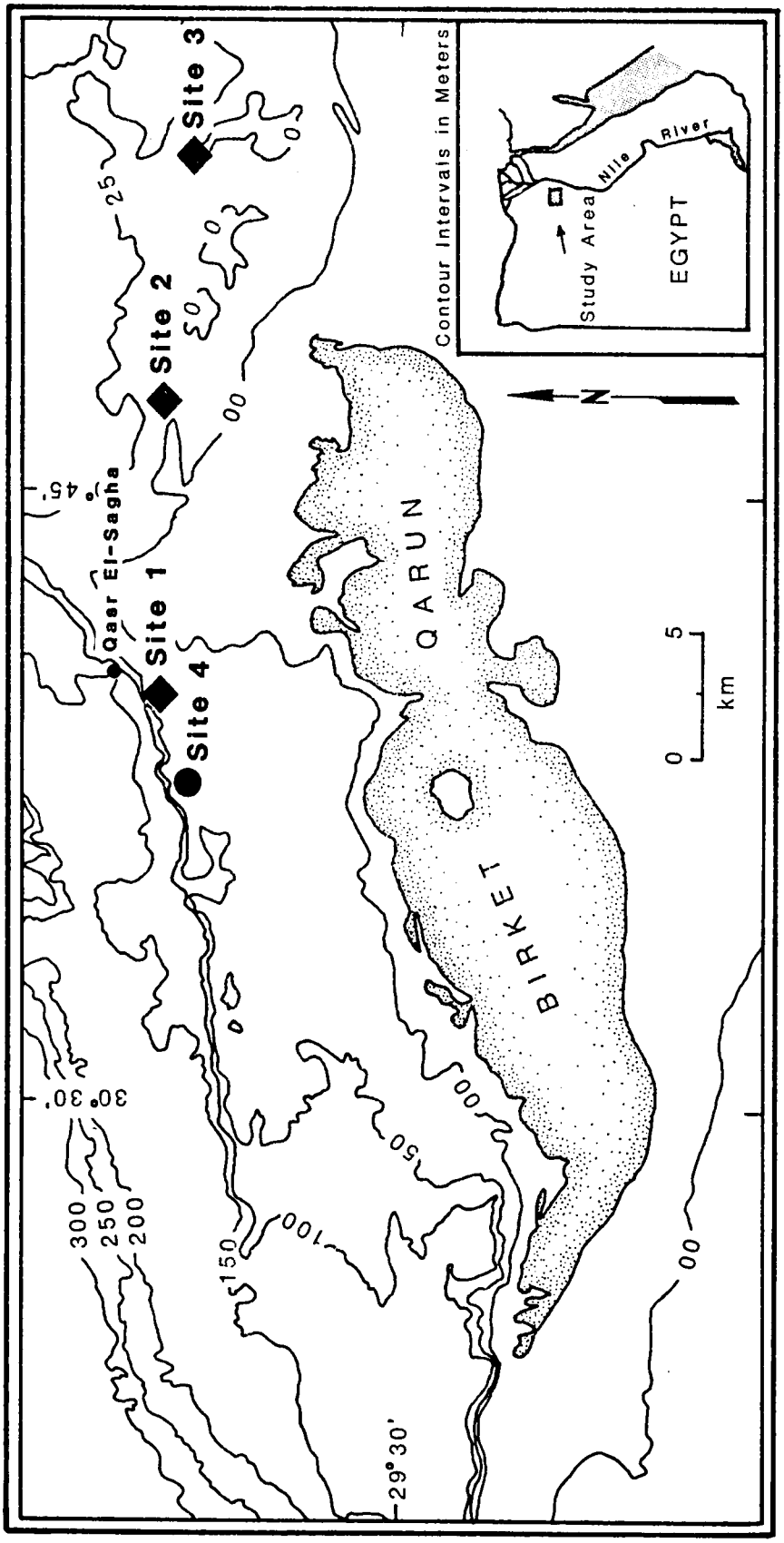


Figure 30. Map showing location of Site 4.

from this site was identified by this author and the results incoporated in this analysis. Details regarding the list of identified elements and measurements will be presented by Buck (in preparation).

Site 5

Site 5 is located 7.5 kilometers south of the western tip of Birket Qarun (Figure 31). This cultural area was investigated by Wenke et al. (1983) who referred to it as FS 1. Site 5 was classified by Wenke et al. as Fayum A. Details concerning Site 5 (FS 1) and the recovered fauna can be found in Wenke et al. (1983) and Wenke and Lane (in preparation).

Sediments from all sites are characterized by hard sandy-silt lacustrine deposits. Artifacts were found to be eroding from this stratum; often partially imbedded in the sediments, removal of the object required the use of army knives and dental tools. Overlying the lacustrine sediments in many parts of the site were wind-blown sands.

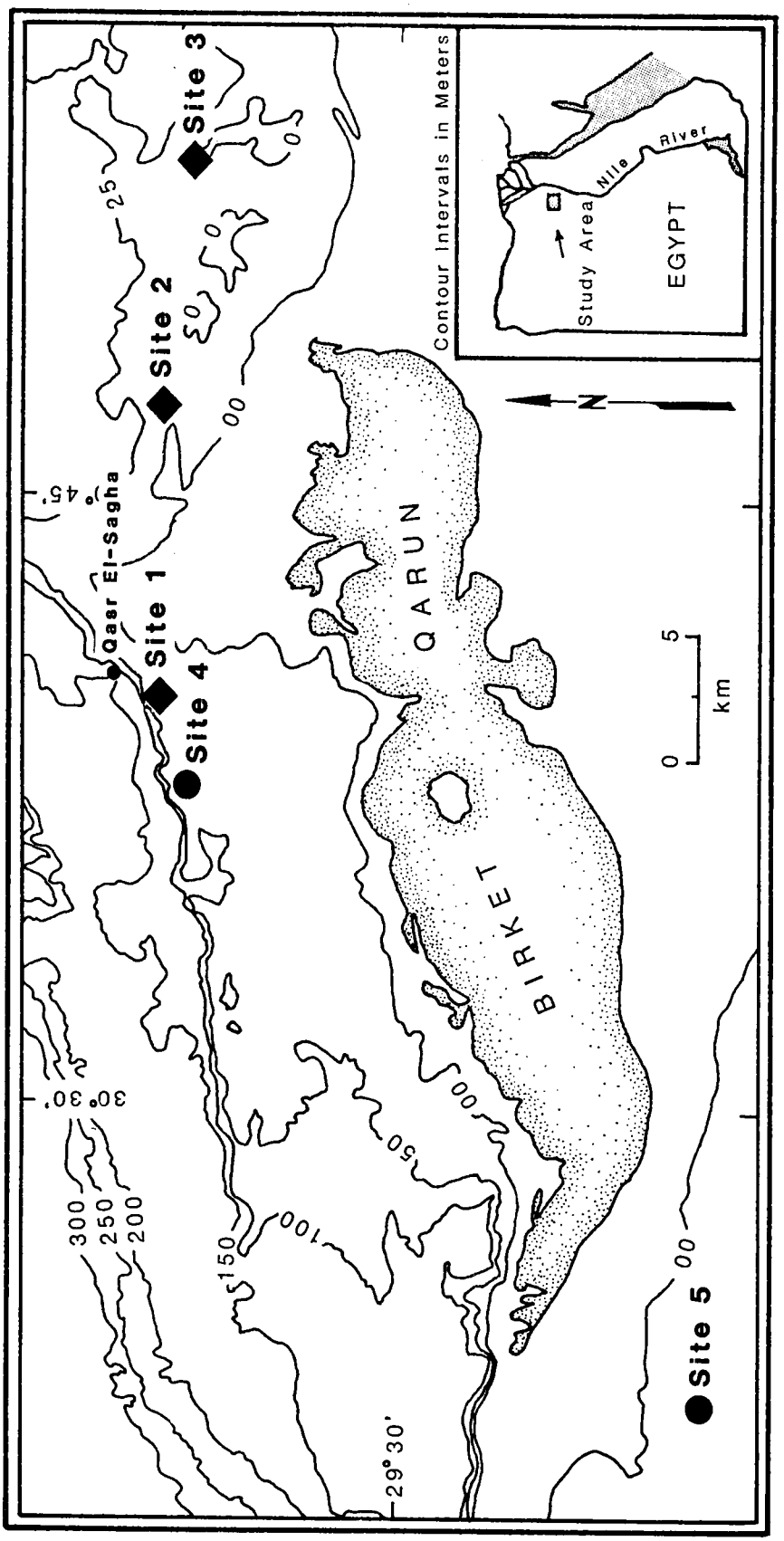


Figure 31. Map showing location of Site 5.

CHAPTER 3

THE FAYUM FAUNA

Identified faunal remains from Sites 1, 2, and 3 are presented in this chapter and arranged according to Class. Details concerning the identified faunal material from Sites 4 and 5 will be presented by Buck (ms. in preparation) and Wenke and Lane (ms. in preparation). Comparative material from the Musuem of Zoology, University of Michigan, The Field Museum of Natural History, and an extensive personal collection were used in making the identifications. Table 4 presents the number of identified specimens per taxon (NISP). Because NISP carries virtually all of the information embodied by the Minimum Number of Individuals (MNI), and because MNI is a function of the aggregative method used to form the specimen clusters, only NISP values are presented (see Grayson 1979, 1983, 1984). Mammalian nomenclature follows that of Osborn and Helmy (1980) and that involving the superclass Pisces follows Greenwood (1966). Avian remains are presented in accordance with Meinertzhagen (1930), White (1965), and Steve Goodman (personal communication 1984). Information concerning the preferred habitat, breeding, and food of identified taxa are also presented in this chapter as a reference guide for later discussions. This information is difficult to obtain and is often incomplete. Consequently, this work presents an important summary of the published data plus additional comments based on observations by this author.

Table 4. Number of identified specimens per taxon (NISP).

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
Barbus spp.	0	1	0	2	4
Bagrus spp.	1	6	0	3	4
Chrysicthys auratus	0	2	0	0	1
Clarias spp.	154	3563	277	415	2855
Synondontis spp.	6	225	17	93	212
Lates niloticus	26	267	13	73	96
Tilapia spp.	0	63	2	5	50
Tetraodon fahaka	1	44	0	0	274
Testudines	334	132	132	32	336
Ixobrychus minutus	0	1	0	0	0
Tadorna tadorna	0	1	0	0	0
Anas crecca	0	2	0	0	0
Anas spp.	16	1	1	0	7
Podiceps cristatus	0	15	0	0	0
Gallinula chloropus	0	1	0	0	0
Porphyrio cf. madigascarensis	0	1	0	0	0
Fulica atra	0	11	0	0	0
Struthio camelus	11	20	44		0
Cygnus cygnus					1
Lepus cf. capensis	0	4	0	0	0
Canidae	1	1	0	6	
Canis spp.	1	9	0	0	19
Vulpes sp.	1	0	0	0	0
Gazella spp.	21	10	2	7	24
Alcelaphus buselaphus	9	1	3	1	5
Ovis/Capra spp.	149	0	3	5	39
Bos spp.	51	4	2	0	5
Ovis/Capra/Gazella	78	6	2	13	34
Bovidae	65	27	17	10	402
Total	914	4386	515	665	4368

Class--Pisces

Boulenger (1905), Pellegrin (1911, 1921, 1933), and Nichols (1928) made the first attempts to divide Africa into ichthyofaunal provinces. Unfortunately, their determinations were based on scanty and inadequate information. More recently, Roberts (1975) divided Africa into 10 ichthyofaunal provinces; the Fayum and the Nile are included within the Nilo-Sudan province (Figure 32).

The Nile system dominates the hydrography of the eastern portion of the Nilo-Sudan province, draining 1,774,000 km^2, which is roughly one tenth of Africa (Roberts 1975). The distance from the Nile's source to the delta by river is 6700 km, the headwaters of the Nile arise in the mountainous area east of the northern end of Lake Tanganyika. The Nile has three major tributaries, the most important being the Blue Nile that arises in the central highlands of Ethiopia. Next in importance is the White Nile, draining lakes Albert and Victoria. The river Atbura, arising in the northwest highlands of Ethiopia, is the last to join the Nile and is the least important contributor of water by volume to the Nile (Said 1975). The lower 2690 km of the Nile flows through desert country where the only tributaries are wadis which supply water only periodically through runoff caused by storms.

Pleistocene climatic fluctuations have had pronounced effects on fish distribution in Africa. Mollusc and fish remains, traces of ancient lakes and river systems, and evidence of human habitation indicate more mesic conditions in areas that are now dry and uninhabitted. Wind blown sands extending north from the Numic and Kalahari deserts, and a



Figure 32. Nilo-Sudan ichthyofaunal province.

belt of stabilized (by vegetation) sand dunes extending south of the present southern limit of the Sahara, indicate that conditions more arid than today also must have occurred in the past (Roberts 1975).

During pluvial periods, fishes were more widely distributed than at present. Lakes were far more numerous and low-lying divides separating rivers and basins were often breached, leaving few barriers for the dispersal of freshwater organisms. During interpluvials, fishes died out as deserts expanded and lakes and river systems dried up. The effects of such changes were especially marked upon the Nilo-Sudanic ichthyofauna (Roberts 1975) (Figure 33).

Climatic fluctuations have induced the cycling of taxa over great areas of the African continent. Taxonomic cycling refers to the succession of taxa that inhabit a region as it becomes available for colonization, gradually acquiring a rich variety of different taxa and then losing taxa as conditions become unfavorable (Roberts 1975). There are large areas in the Sahara and East Africa that are today uninhabited by fishes; these are believed to be examples of regions where the cycle has not been reinstated. Adjacent to these regions are areas where the diversity of taxa is indicative of an early stage of colonization.

In areas such as brackish lagoons and coastal streams the cycle is initiated by peripheral-division fishes (e.g., Anguillidae, Mugilidae, Gobiidae). Such fish live readily in both fresh and saltwater and the sea serves as a highway for their dispersal (Roberts 1975). In the interior continental areas where there is no direct access to the sea, the cycle is initiated by primary and secondary division fishes. Primary division fishes are obligatory freshwater fish which cannot tolerate

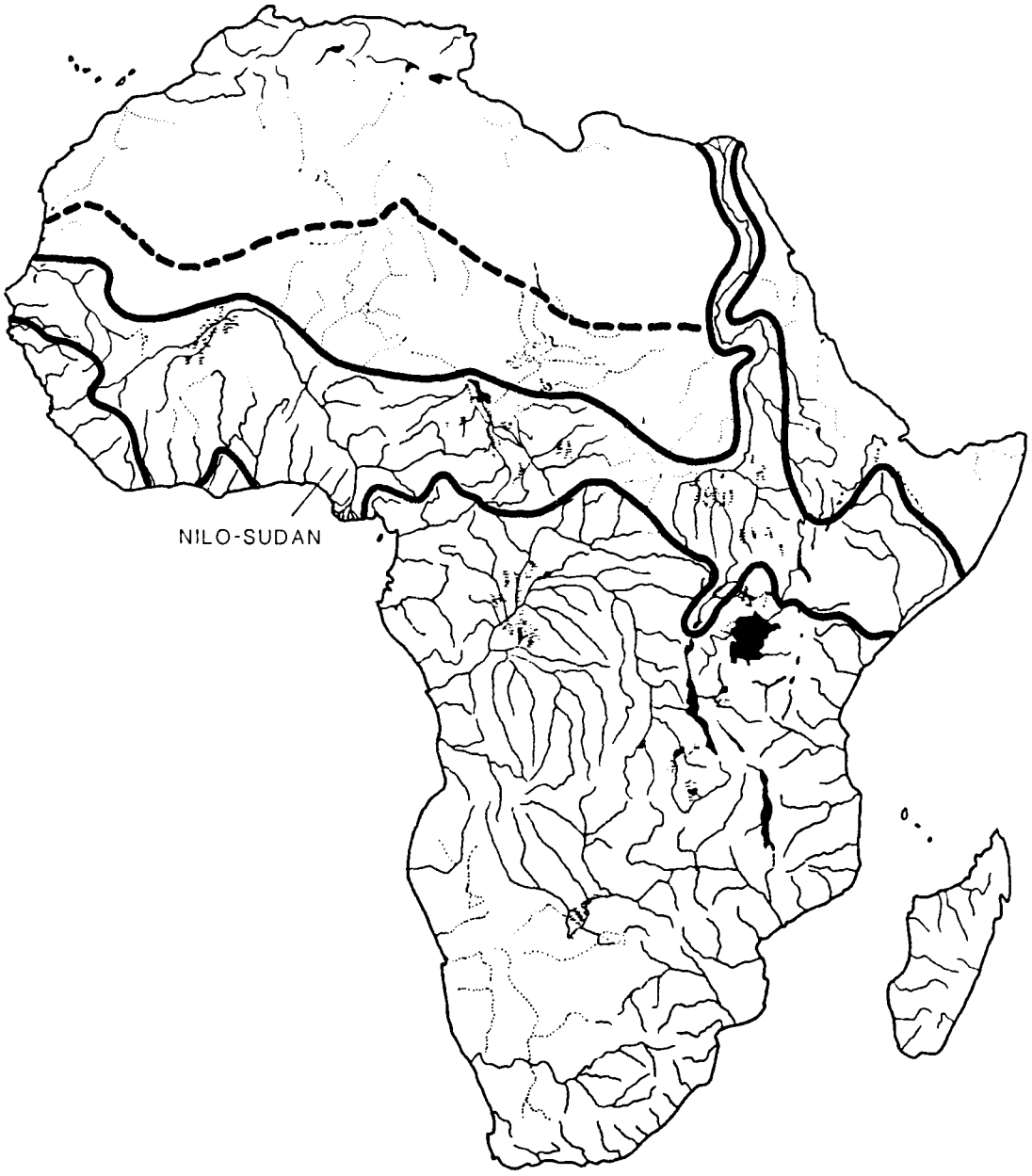


Figure 33. Broken line indicates approximate extent of Nilo-Sudan fish fauna during pluvials.

saltwater. Secondary division fishes live almost exclusively in freshwater but can tolerate saltwater well enough to disperse through it.

African freshwater fishes are also referred to as first order, second order, or third order families according to their occurrence in the taxon cycle. First order families are characterized by being able to survive in bodies of water with representatives of only one family. In Egypt the most important of these families are the Anguillidae, Cyprinidae, Clariidae, Cyprinodontidae, and the Cichlidae. Second order families, those with species which live in places inhabited by representatives of from one to five other fish families, include the Lepidosirenidae, Polypteridae, Characidae, Bagridae, Schilbeidae, Malapteruridae, Mochokidae, Anabantidae, and the Mastacemblelidae. Third order families, or those in which representatives are only encountered in situations where there are representatives of more than five other fish families, include the Clupeidae, Denticipitidae, Osteoglossidae, Notopteridae, Mormyridae, Citharinidae, Centropomidae, and the Tetraodontidae (Roberts 1975). Fish faunas of the Sahara desert consist entirely of first and second order families. Third order families occur only in the savannah and desert rivers of the Nilo-Sudan ichthyofaunal province.

The history of Birket Qarun is similar in many ways to what has been described above. During periods of increased effective precipitation and/or periods when Nile floods were high enough to breach the Nile-Fayum divide, Birket Qarun increased in depth, area, and species diversity. When Nile floods were reduced or conditions became more arid

the cycle was reversed. Birket Qarun today is saline and marine species (Mugil capito and Mugil cephalus) introduced for comercial purposes now dominate the lake's fauna (Boraey 1980).

Order: Ostariophysi
Family: Cyprinidae
Genus: Barbus sp. -bynii

Site 2 material: 1 right hyomandibular. NISP=1.

No genus of Nile fishes stands in more need of a thorough revision than Barbus. The large number of specimens collected for Boulenger's (1907) work revealed a great deal of variation between members of the same species. Further studies will no doubt define some forms currently assigned to separate species as local variants of a common species. Greenwood (1966) has presented a recent revision of some east African Barbus species. Unfortunately, the list of revisions does not include many Nilotic forms that are equally in need of revision.

Boulenger (1907) identified 35 species of Nile Barbus. The three most common species are: B. duchensii, which inhabits the Blue Nile; B. lobogenys which has been collected in the Cairo area; and B. bynni, one of the best known and most widley distributed fishes of Egypt with specimens having been taken from all parts of the White and Egyptian Nile. Pekkola (1919) recognizes three species living in the White Nile: B. bynni, which he states in not very abundant, and B. anema and B. pumilus which are quite common.

Barbus bynni prefers clear waters and feeds on molluscs, small Nodulania, and Mutela, while B. anema and B. pumilus inhabit shore

areas covered with vegetation (Pekkola 1919). The latter two species are considered herbivorous.

Sandon and Tayib (1953) note that B. bynni has a varied diet but believe it to be mainly herbivorous. They were unable to confirm Pekkola's statements regarding B. bynni's diet of molluscs. They report, however, that one specimen did contain the remains of the fish Labeo.

In the Nozha-Hydrodrome, located on the Nile Delta near the Mediterranean Sea, B. bynni spawns from April to September. In Lake Nassar, the reservoir behind the Aswan Damn, B. bynii were reported to have ripe ovaries from late spring through early summer (Hashem and El Agamy 1977).

Suborder: Siluroidea
Family: Bagridae
Genus: Bagrus spp. -bayad

Site 1 material: 1 left articular. NISP=1.

Site 2 material: 1 supraethmoid; 1 right premaxilla; 1 left articular; 1 left operculum; 1 right pectoral spine; 1 left pectoral spine. NISP=6.

Three species of Bagrus, B. bayad, B. docmac, and B. degeni, inhabit the Nile (Boulenger 1907). Bagrus bayad is known from the Egyptian Nile, Blue Nile, and White Nile. Bagrus docmac has been collected from the Nile Delta to Lake Victoria and from the tributaries of the Blue Nile. Bagrus degeni is known only from Lake Victoria. It has also been collected in Uganda (Greenwood 1966). Boulenger notes that Bagrus avoids salt water and may be found living only in freshwater. It was thought that Bagrus fed exclusively on fish (Pekkola 1919; Sandon and

Tayib 1953) but studies by Sandon and Tayib (1953) of stomach contents show that B. docmac preys upon a wide variety of species. Their diet includes fish, molluscs, and insects. Sandon and Tayib (1953) believe it to be a bottom feeder, eating any kind of animal of suitable size. The spawning season for B. bayad occurs in May.

Species: Chrysichthys auratus -abu riyal

Site 2 material: 1 right articular; 1 left pectoral spine. NISP=2.

Sandon and Tayib (1953) place this genus in the family Bagridae. They state that it eats small molluscs, fish, and insect larvae and that it is believed to be a bottom feeder, eating any kind of animal of suitable size. Boulenger (1907) states that two forms, C. auratus and C. rueppelli, inhabit the Nile but only C. auratus should stand as a distinct species. There seems to be some confusion as to the characters used in separating the two forms. Boulenger believes representatives of this genus to be carnivorous, feeding chiefly on fishes, crustaceans, and molluscs.

Family: Clariidae
Genus: Clarias spp. -armoot

Site 1 material: 127 roof cranial elements; 1 supraethmoid; 1 parasphenoid; 1 basioccipital; 2 right articulars; 1 left articular; 1 unsided articular; 1 left hyomandibular; 4 right pectoral spines; 4 left pectoral spines; 2 unsided pectoral spines; 9 vertebrae. NISP=154.

Site 2 material: 3147 cranial roof elements; 52 supraethmoids; 12 palatines; 13 maxillae; 2 vomer; 24 parasphenoids; 2 basioccipitals; 8 right dentarys; 12 left dentarys; 1 unsided dentary; 31 right articulars; 30 left articulars; 2 right hyomandibulars; 12 unsided hyomandibulars; 11 ceratohyals; 23 epihyals; 9 right opercula; 6 left opercula; 19 right cleithra; 16 left cleithra; 33 unsided cleithra; 34 right pectoral spines; 33 left pectoral spines; 26 unsided pectoral spines; 5 vertebrae. NISP=3563.

Site 3 material: 252 cranial roof elements; 8 supraethmoids; 1 left dentary; 1 left articular; 3 right articulars; 1 epihyal; 1 left

operculum; 5 left cleithra; 2 unsided cleithra; 1 left pectoral spine; 1 right pectoral spine; 1 unsided pectoral spine. NISP=277.

Two species of Clarias are currently recognized as inhabbitting the Nile, although Greenwood (1966) notes that the Clarias species of Africa are in urgent need of taxonomic revision. Intraspecific variability is high and many so-called species will undoubtedly prove to be merely geographical variants of a single widespread species. Some revisions have been made (cf. Bruton 1979), although no revisions based on Nilotic species have been reported.

The hardiness of Clarias is legendary among the fisherman and villagers of Egypt. Although the stories are undoubtedly exaggerated, there is no doubt that Clarias can tolerate conditions which would kill most other fishes. Clarias prefer shallow deoxygentated waters (Greenwood 1966, 1968; Roberts 1975). The ability of Clarias to survive in foul, stagnant water is due to an elaborate accessory breathing organ which enables these fishes to utilize atmospheric oxygen. The accessory organs are in the form of highly branched bodies developed from two of the gill arches on each side of the fish. These bodies are contained within an expansion of the gill-chamber, which is lined with a highly vascular skin and protected by the bones of the skull. Both the tissue covering the branched organ and the skin lining the suprabranchial chamber have the same microscopic structure as the normal gill-filaments (Greenwood 1966). It is across these surfaces that oxygen is absorbed from the air. Even though its gill filaments are well developed, it appears that Clarias is dependent on the additional supply of oxygen for

survival. Fishes prevented from gaining access to the surface drown (Greenwood 1966).

The amphibious habits of Clarias may explain its ability to rapidly populate new habitats. There are many records from various parts of Africa of Clarias moving overland from one body of water to another. Clarias move across land surfaces by a combination of lateral, fish-like body and tail undulations and by use of their pectoral fin spines (personal observation). When temporary streams and swamps dry up, Clarias are reputed to burrow in the mud and remain there until the area is again flooded. However, such behavior has yet to be substantiated and warrants further study.

Species: Clarias angularis

Loat stated that this fish comes out of the water on to the ground to eat vegetation (Pekkola 1919). There exists, however, no records to substantiate this. Even Egyptian fisherman know nothing of this habit (Pekkola 1919; personal observation). Pekkola (1919) states that this fish feeds on molluscs and fish. One specimen examined by Pekkola (1919) contained algae in its stomach but no specimens contained any terrestrial plant material. Sandon and Tayib (1953) report that specimens taken near Khartoum contained only fish remains. One large specimen examined by Sandon and Tayib contained mollusc shell fragments, fish scales, crustacean appendages, and some mud with diatoms. Fish collected near Cairo by this author contained only fish remains, sometimes mixed with mud.

Species: Clarias lazera

This species is the most common Clarias in the Nile today (Greenwood 1968). Welman (Sandon and Tayib 1953) states the food of this fish as frogs, molluscs, and weeds. Worthington (Sandon and Tayib 1953) regards it as mainly predacious, feeding on Tilapia and Haplochromis, but also able to filter minute animals and plants from the water by means of its long closely-set gill rakers. Greenwood (1966) reports that the food of this fish in Uganda includes insect larvae, molluscs, planktonic organisms, and water weeds.

Greenwood and Todd (1970) state that fish of this genus can be easily collected by hand during the spawning season. However, there are no published records of when spawning occurs for C. lazera or C. angularis in the Nile. The spawning season is thought to correspond with the annual period of inundation occurring in the fall. However, specimens of C. lazera collected by me near Luxor contained mature eggs (cf. Bruton 1979) as early as April 24. Unfortunately, sampling did not continue past June so the duration of this condition is unknown. Greenwood (1966) notes, however, that C. mossambicus (now C. gariepinus), a species whose relationship to C. lazera is in need of investigation (some authors consider C. lazera as a variant of C. gariepinus), breeds in small temporary streams which flow into Lake Victoria during the spring rainy season (April) and again during the winter rains (December) (Greenwood 1955).

Further evidence appears to indicate that Clarias may be an opportunistic breeder. Spawning has been triggered in some Clarias species by artifically raising the water level of the lakes in which they live.

When conditions become favorable, spawning can commence within 8-36 hours (Bruton 1979). Two or as many as three spawning sessions can occur during a single season depending on environmental conditions.

It is likely that no single physical or chemical factor is responsible for triggering the spawning of Clarias species. Changes in water level, duration of daylight hours, chemistry, ph, temperature, water clarity, flow velocity, and biological factors such as the flooding of marginal plants, associated chemical changes, and access to suitable spawning sites may all be important factors conditioning spawning activities (Bruton 1979; Whitehead 1959; Qasim and Qayyum 1961).

Heterobranchus longifilis, a close relative of Clarias, is known to occur in the Nile south of Luxor. Skeletal elements of this fish, particularly small pieces of the cranium, can be confused with those of Clarias (Greenwood 1976). However, this fish, although abundant in the White Nile (Pekkola 1919), is very rare near Luxor and is unknown to fishermen from areas north of Luxor. Additionally, clariid articular bones recovered from the Fayum can all be assigned to Clarias. The articular and palatine bones can be used to separate these genera.

Family: Mochokidae
Genus: Synodontis spp. -schall, gargoor

Site 1 material: 4 right pectoral spines; 1 left pectoral spine; 2 2nd dorsal spines. NISP=6.

Site 2 material: 13 cranial roof elements; 1 right operculum; 27 right cleithra; 24 left cleithra; 2 unsided cleithra; 1 right humeral process; 4 unsided humeral processes; 28 right pectoral spines; 31 left pectoral spines; 56 unsided pectoral spines; 35 2nd dorsal spines; 2 1st dorsal spines; 1 cranial spine-base. NISP=225.

Site 3 material: 2 cranial roof elements; 1 right operculum; 2 left cleithra; 4 left pectoral spines; 1 right pectoral spine; 5 unsided pectoral spines; 1 2nd dorsal spine; 1 dorsal spine. NISP=17.

Thirteen species of Synodontis are known to inhabit the Nile (Boulenger 1907). As a rule members of this genus are omnivorous bottom-feeders (Pekkola 1919; Sandon and Tayib 1953). Boulenger (1907) states that they eat seeds as well as fish and he credits this fish with eating filth of any kind. Inspection of the stomach contents of Synodontis schall taken near Cairo show a diet of insects, molluscs (Corbicula), fish remains, and green plant material (personal observation).

Habitat preferences of Synodontis vary according to species. Most species prefer deep open water environments although some, such as S. schall, can be recovered occasionally from inshore areas. Nile fisherman from Cairo, El Minya, and Luxor habitualy work in the deeper open waters of the Nile when fishing for Synodontis. Inspection of taxa collected from offshore fishing forays substantiate this claim. Near shore catches seldom produce Synodontis; Tilapia is always the most abundant taxon represented in near shore catches (personal observation). Little is known of Synodontis breeding habits.

Order: Percomorphi
Suborder: Percoidea
Family: Centropomidae
Species: Lates niloticus -ijl, samoos, nile perch

Site 1 material: 2 left premaxillae; 2 parasphenoids; 1 basioccipital; 2 left dentarys; 1 right articular; 1 unsided articular; 2 right quadrates; 1 left quadrate; 1 left hyomandibular; 2 right preopercula; 2 right cleithra; 1 left cleithrum; 2 pterygiophores; 6 vertebrae. NISP=26.

Site 2 material: 1 premaxilla; 10 right maxilae; 7 left maxillae; 5 vomer; 7 parasphenoids; 2 basioccipitals; 15 right dentarys; 11 left dentarys; 1 unsided dentary; 22 right articulars; 24 left articulars; 2 unsided articulars; 4 left quadrates; 11 right quadrates; 1 hyomandibular; 11 right preopercula; 6 left preopercula; 2 unsided preopercula; 6

right opercula; 9 left opercula; 9 right cleithra; 15 left cleithra; 14 dorsal spines; 1 1st anal spine; 71 vertebrae. NISP=267.

Site 3 material: 1 right maxilla; 1 parasphenoid; 1 left dentary; 2 right dentarys; 3 left articulars; 1 left quadrate; 1 right quadrate; 1 left preoperculum; 1 left operculum; 1 cleithrum. NISP=13.

Only one species of Lates is known from the Nile (Boulenger 1907) and it is widespread and occurs in all major African river basins including the Chad, Niger, Senegal, and Volta. Lates niloticus thrives under lacustrine as well as riverine conditions, and large populations exist in Lakes Rudolf, Albert, and Tana (Hopson 1972). Loat (Boulenger 1907) states that Lates was particularly abundant in Birket Qarun.

Pekkola (1919) noted that L. niloticus predominately feeds on fish, but some evidence of molluscs in the diet has since been recorded. Sandon and Tayib (1953) state that specimens examined by them contained only the remains of fish. Worthington (Sandon and Tayib 1953) has reported that Lates eat plankton and prawns until they reach a size of about four inches long, then they prey solely on fish. In a more recent study by Hopson (1972), L. niloticus from Lake Chad reportedly ate predominately fish in the colder months of the year while changing to prawns and other crustaceans during the warmer months. He states that molluscs were eaten by this fish from August to October.

Lates niloticus reach tremendous sizes, and examples of specimens over 70 kg have been recorded from all major river systems. Individuals over 120 kg have also been occasionally reported.

Lates prefer deep, well-oxygenated waters (Greenwood 1966; Roberts 1975). This fish is intolerant of even moderately deoxygenated waters and dies of asphyxiation if the oxygen content of the water falls below a level which would not seriously affect most other species (Fish 1956). Lates also exhibits a behavioral change when it matures to a large size (ca. 40 cm in length). Large Lates reportedly live in crevices and other secure places and only dart out to attack prey. Owing to these special living circumstances large L. niloticus are not usually caught by normal fishing methods (i.e., netting) (Hashem and Hussein 1973).

The breeding habits of L. niloticus from the Egyptian Nile are not well known: in the Nazha-Hydrodrome, L. niloticus are known to spawn in late May (Hashem and Hussein 1973); Lates living in Lake Nassar are known to possess ripe ovaries in April (Latif and El-Sayed 1974). Hopson (1972), however, has compiled considerable data concerning the breeding habits of this species from Lake Chad. He states that observations on gonads indicate that spawning could take place at all times of the year, but evidence for spawning in Lake Chad from December through Feburary is lacking. Spawning activity rose quickly to a peak in April and May. Kechington (1939) observed that the gonads of L. niloticus from the Blue Nile ripen between December and April; the first spent fish appeared in January with the remaining spent individuals rising to peak proportions in April. He gives warmer water conditions as the reason for the early spawning. Nevertheless, temperature may not be the governing facter as L. mariae from Lake Tanganyika, where temperatures

do not vary more that 2 degrees celcius during the entire year, spawn seasonally as well.

Family: Cichlidae
Genus: Tilapia spp. -bolti

Site 2 material: 1 left premaxilla; 1 vomer; 2 basioccipitals; 1 articular; 3 left quadrates; 1 right quadrate; 2 left hymandibulars; 1 right hyomandibular; 18 right opercula; 14 left opercula; 15 dorsal spines; 1 anal spine; 2 pterygiophores; 1 vertebra. NISP=63.

Fish of this genus are all herbivorous although different species exhibit different feeding patterns, ranging from microphagous algal bottom-feeders to those which eat the larger aquatic plants (Sandon and Tayib 1953). Boulenger (1907) states that there are over 70 species of Tilapia. Tilapia zilla and T. niloticus are the dominant Nile species (Pekkola 1919), although numerous specimens of T. galilaea have been collected from the Nile as well (Pekkola 1919; Sandon and Tayib 1953; Greenwood 1966). Tilapia zilla and T. nilotica occur in great abundance in the Egyptian Nile (personal observation).

Tilapia nilotica and T. galelaea are mouth brooders, the female carrying the young. Tilapia zilla is not a mouth brooder, but instead spawning takes place in a prepared nest. After spawning, one of the parents remains on guard, maintains a current of water over the nest and cleans away any detritus that settles (Greenwood 1966). Boulenger (1907) also states that the parent exhibits protective behavior by attempting to drive intruders away from the nest area.

Worthington (Sandon and Tayib 1953) reports that in Uganda T. nilotica eats plankton and does not discriminate between the different animals of which it is composed. In waters where plankton is scarce, this fish eats insects or water weeds. Observations by the African

Fisheries Resource Organization made on stomach contents showed much of the plant remains to be undigested (Sandon and Tayib 1953). It appears that the fish may depend on the diatoms growing on the plants rather then the plants themselves (Sandon and Tayib 1953; Greenwood 1966; Fish 1955).

Sandon and Tayib (1953) describe T. zilla as a weed eater, feeding on much coarser vegetation than either T. nilotica or T. galilaea. However, studies show that the leaves and stems of the aquatic plants eaten, although masserated, were not fully digested. Only the diatoms appear to be completely utilized (Sandon and Tayib 1953). Tilapia galilaea feeds on diatoms recovered from the river or lake bottom. Unlike other species of this genus, when stomach contents of T. galilaea were examined, plant fragements were found to be scarce (Sandon and Tayib 1953).

Near Khartoum, T. nilotica breeds during the end of April and the beginning of May (Sandon and Tayib 1953). Tilapia nilotica near Alexandria spawn from the second half of May to mid July (El Zarka et al. 1970). All three species prefer to live in shallow inshore waters, bays, and lagoons (Sandon and Tayib 1953).

Order: Tetradontiformes
Family: Tetraodontidae
Species: Tetraodon fahaka -tambaira, puffers

Site 1 material: 1 premaxilla/dentary. NISP=1.

Site 2 material: 44 premaxillae/dentaries. NISP=44.

Pekkola (1919) and Sandon and Tayib (1953) state that this fish feeds only on molluscs. Pekkola (1919) mentions Cleopatra bulimoides as

a species identified from Tetraodon stomach contents. Grasses have been recovered from the intestines of one specimen (Pekkola 1919). Nothing is known of the breeding habits or habitat preferences of this taxon.

Class--Reptilia

Order: Testudines

Site 1 material: 344 carapace/plastron fragments. NISP=344.

Site 2 material: 132 carapace/plastron fragments. NISP=132.

Site 3 material: 132 carapace/plastron fragments. NISP=132.

Work on turtle remains in the Sudan by Broin (Gautier 1983) suggests that the turtle fauna of the early and mid-Holocene was probably more varied than that of today. The remains recovered from the Fayum appear to belong to the family Trionychidae, and possibly to the genus Trionyx; however, positive identifications were not possible due to the fragmented nature of the remains.

Class--Aves

If one considers the localities north of the tropics where birds can winter, Egypt is the only suitable area between Spain and Iraq (Meinertzhagen 1930). The Egyptian delta and the Nile offer and excellent haven for migrating birds and thousands of ducks, waders, and many other groups can be found wintering in Egypt.

The Sinai, while it constitutes the sole land-bridge between Africa and Asia, is the winter resort of few bird species. Rather, it is used as a migration corridor by countless numbers of birds in both autumn

and spring. The line of flight for migrating birds appears to be northeast-southwest. That is, migration is directed in autumn from Asia towards the Nile Valley and in spring from the Nile Valley towards Asia (Meinertzhagen 1930). There is litle evidence of migrations either up or down the Red Sea. If such flyways were used, they would be noticed because the Red Sea and Suez constitute one of the buisiest trade routes in the world.

While the birds represent one of the best studied groups of Egyptian vertebrates, many problems remain to be solved. For example, knowledge of the migration patterns to and from the tropics is still incomplete and many remote parts of Egypt have never been visited by ornithologists.

The identification of avian remains recovered from the Fayum were made by Steve Goodman of the University of Michigan, Museum of Zoology, Ann Arbor.

Order: Struthioniformes
Family: Struthionidae
Species: Struthio camelus -ostrich

Site 1 material: 11 eggshell fragments. NISP=11.

Site 2 material: 20 eggshell fragments. NISP=20.

Site 3 material: 44 eggshell fragments. NISP=44.

Struthio camelus no longer occurs in the deserts surrounding the Fayum. The last published record of ostrich in the Egyptian Western Desert was in 1935 when one was caught halfway between Kharga and Dakhla oases (Al-Hussaini 1959). The distribution of eggshell fragments in the

Western Desert indicate that the ostrich may formerly have been a widespread bird in the region (Steven Goodman, personal communication 1984).

Order: Podicipediformes
Family: Podicepedidae -grebes
Species: Podiceps cristatus -great crested grebe

Site 2 material: 6 coracoids; 1 distal humerus; 1 proximal ulna; 1 proximal carpometacarpus; 1 complete carpometacarpus; 1 complete femur; 2 proximal tarsometarasi; 1 distal tarsometatarsus; 1 complete tarsometatarsus. NISP=15.

Podiceps cristatus is reported to have been a former breeding resident of the Nile Delta (Meinertzhagen 1930); there are, however, no recent published records of nesting birds. Great crested grebes winter in considerable numbers on Lake Qarun. Meininger and Mullie' (1981) counted 2808 individuals between January 10 and 12, 1979 and 3440 between 31 December 1979 and 2 January 1980. It winters in part on shallow waters with emergent vegetation. This species is sold for food in the wild bird markets of the Nile Delta (Meininger and Mullie' 1981; Goodman and Hobbs 1985).

Order: Ciconiiformes
Family: Ardeidae -herons and bitterns
Species: Ixobrychus minutus -little bittern

Site 2 material: 1 distal tibiotarsus. NISP=1.

The little bittern is a breeding resident in the thick reed beds of the Fayum (Meinertzhagen 1930). It is a skulking and very secretive bird. The Egyptian breeding population is augmented during the winter by European migrants (Meininger and Mullie' 1981).

Order: Anseriformes
Family: Anatidae
Species: Tadorna tadorna -shelduck

Site 2 material: 1 proximal section of carpometacarpus. NISP=1.

Tadorna tadorna is a winter visitor to the Fayum, generally between early December and late March (Meinertzhagen 1930). A total of 16 individuals were counted on Lake Qarun between January 10-12, 1979 (Meininger and Mullié 1981). This species prefers to winter in shallow saline waters and along mud flats (Meininger and Mullié 1981). It is seen not uncommonly in the wild bird markets of the Nile Delta (Goodman and Hobbs 1985).

Genus: Anas spp. (A. acuta, A. clypeata, A. strepera, A. penelope size group)

Site 1 material: 8 coracoids; 1 proximal scapula; 3 proximal ulnae; 3 distal ulnae; 1 complete ulna. NISP=16.

Site 2 material: 1 corocoid. NISP=1.

Site 3 material: 1 corocoid. NISP=1.

The bone remains listed above are referable to medium-sized members of the genus Anas. Because many of the bones are worn, and because of the similarity in size and osteological morphology among members of this genus, it is inappropriate to make specific assignments. The following species have been recorded in the Fayum and are within the range of medium-sized ducks belonging to the genus Anas; A. penelope (widgeon) is a winter visitor to Egypt and has been sighted from late September to late April (Meinertzhagen 1930). Over 1800 specimens were counted on Lake Qarun from January 10 to 12, 1979 (Meininger and Mullié 1981). The gadwall (A. strepera) is also a winter visitor to Egypt residing in the area from October to late March (Meinertzhagen 1930). Fifteen individuals of this species were identified on Lake Qarun between December 31 1979 and January 2, 1980 (Meininger and Mullié 1981). Meininger and

Mullié (1981) observed 110 pintail (A. acuta) on Lake Qarun between December 31, 1979 and January 2, 1980. The pintail is a winter visitor to the Fayum, generally occurring from September to late April. Lake Qarun is also an important wintering area for A. clypeata (shoveler). Meinertzhagen (1930) states that this species generally arrives in October and leaves in April. Over 11,500 individuals were counted over a three day period during the winter of 1979/80 (Meininger and Mullié 1980). All of these ducks tend to prefer shallow waters with emerging vegetation. Furthermore, all are sold as food in the wild bird markets of the Nile Delta (Meininger and Mullié 1981; Goodman and Hobbs 1985).

Species: Anas crecca -green-winged teal

Site 2 material: 2 coracoids. NISP=2.

This species is a common winter resident in the Fayum between early September and late March (Meinertzhagen 1930). Meininger and Mullié (1981) counted about 1000 individuals between January 10 and 12, 1979 and 522 between December 31, 1979 and January 2, 1980. On wintering grounds it often inhabits shallow eutrophic waters. Teal have been noted in the wild bird markets of the Nile Delta (Meininger and Mullié 1981; Goodman and Hobbs 1985).

Order: Gruiformes
Family: Rallidae -rails and coots
Species: Gallinula chloropus (Moorhen)

Site 2 material: 1 distal humerus. NISP=1.

This species is a breeding resident of Egypt (Meinertzhagen 1930) and during the winter months the Fayum population is augmented by Palearctic migrants. It inhabits areas of open water that are often

fringed with dense vegetation. Moorhens are regularly sold for food in the wild bird markets of the Nile Delta (Meininger and Mullié 1981; Goodman and Hobbs 1985).

Species: Porphyrio cf. madagascariensis -green-backed gallinule

Site 2 material: 1 femur. NISP=1.

This species is known to have formerly bred in the Fayum (Meinertzhagen 1930). It is still a common resident in the thick reed beds of the lower Nile and the Nile Delta.

Species: Fulica atra -coot

Site 2 material: 1 coracoid; 2 proximal carpometacarpi; 4 distal carpometacarpi; 3 complete carpometacarpi; 1 distal tibiotarsus. NISP=11.

Coots are suspected to breed in the Fayum (Meinertzhagen 1930). Between early November and late March considerable numbers of Palearctic migrants visit the area. Meininger and Mullié (1981) counted 9,085 coots between 10 and 12 January 1979 and 18,807 between December 31 1979 and January 2 1980 on Lake Qarun. It is one of the most common species in the Nile Delta bird markets, with over 1000 individuals sold on some days (Meininger and Mullié 1981; Goodman and Hobbs 1985).

Class--Mammalia

Due to the striking similarities in flora, the continuous desert extending from the Sahara through the Middle East and into Northwest India is known as the North African Indian Desert Province (Muschler 1912) or the Saharo-Sindian Phytogeographic Region (Shaw 1931; Zohary 1954). The mammalian fauna adapted to these deserts is referred to as

Saharo-Sindian (Harrison 1964; Ranck 1968). Because terrestrial species found in this region have their closest affinities with Europe and Southwest Asia, North Africa is also considered a part of the Palearctic Biogeographic Region. Therefore, from a strictly zoogeographical point of view, this area should be called the Saharo-Sindian Sub-Region of the Palearctic (Osborn and Helmy 1980). Taxa confined to or having the main part of their range south of the Sahara are included in the Afro-tropical region.

Most mammalian desert species found in Egypt are indigenous to either North African or southwest Asian deserts. Penetration east and west has been restricted by the Isthmus of Suez and the Nile Valley. Most of the faunal interchange between these deserts and the subsequent isolation took place during the upper Pleistocene (Zahawi and Wahram 1957; Tchernov 1968).

Species of Saharo-Sindian mammals that are widely distributed in North Africa and Southwest Asian deserts include Vulpes rueppelli (sand fox), Fennecus zeida (fennic fox), Felis margarita (sand cat), Gazella dorcas (dorcas gazelle), Jaculus jaculus (lesser jerboa), Meriones libycus (Libyan jird), M. crassus (silky jird), and Psammomys obesus (fat sand rat). Crocidura floweri (Flower's shrew) in the Nile Valley, Dipodillus mackilligini (Mackilligin's dipodil) in the southern portion of the Eastern Desert, and Gerbillus perpallidus (pallid gerbil) in the northern Western Desert are endemic to Egypt. North African species in Egypt that are not known to occur east of the Nile Valley and Delta are Paraechinus deserti (desert hedgehog), Gazella leptoceros (white

gazelle), Poecilictus libyca (striped weasel), Dipodillus simoni (Simon's dipodil), D. campestris (large North African dipodil), and Meriones shawi (Shaw's jird).

Species of southwest Asian origin that have penetrated into North Africa include Spalanx ehrengergi (mole rat) which occur as relict populations in the Western Mediterranean Coastal Desert of Egypt, the Cyrenaican Plateau and Coastal Plain of Libya, and Dipodillus dasyurus (rough-tailed dipodil) which occurs in Sinai and the northern part of the Eastern Desert.

A few species of known Ethiopian origin have penetrated Egypt via the Nile Valley; these include Crocidura flavescens (giant musk shrew), C. nana (dwarf shrew), and Arvicanthis niloticus (grass rat). Also, two desert-adapted species of Ethiopian origin, Ictonyx striatus (zoril) and Proteles cristatus (aard wolf), have been collected in the deserts of southeastern Egypt.

Relicts of Palearctic origin include Crocidura suaveolens (lessor white toothed shrew) in the Sinai and the Western Mediterranean Coastal Desert and Suncus etruscus (pigmy white toothed shrew) in the Nile Delta. Nesokia indica (bandicoot rat), of Oriental or Indian origin, occurs sporadically in Egypt and the Arabian Peninsula. Suncus murinus (house shrew), another Oriental form and a commensal of man, is known from the port city of Suez. Its distribution in the Arabian Peninsula probably indicates transportation by man (Harrison 1964). Mus musculus (house mouse), Rattus rattus (black rat), and R. norvegicus (brown rat)

no doubt arrived in Egypt and other parts of the Saharo-Sindian Region via man.

Special Adaptations of Desert Mammals

Warm dry air has poor sound-carrying qualities (Osborn and Helmy 1980) and Lay's (1972) data show a high correlation between specialization in audio-sensitivity and environmental aridity. The enlarged tympanic and mastoid chambers of the middle ear of certain desert rodents, foxes, cats, and weasels, and probably the swollen pterygoids in hedgehogs, increase their ability to hear low-frequency sounds in warm dry air (Legouix et al.1954; Wisner et al. 1954; Vaughan 1972; Harrison 1972) or vibrations in densely packed sand. Beecher (1969) suggested that, in addition to promoting better hearing, air trapped in the sinuses of the middle ear provides an accessory motion sense in saltatorial forms.

Soles of the feet of sand-dwelling mammals are usually covered with hair; this characteristic is thought to be advantageous for movement on sand. Hairy-footed rodents never penetrate the soft, salty, clinging soils of marshes as do the barefooted dipodils, nor do they climb rock walls and leap from boulder to boulder like the dipodils (Osborn and Helmy 1980). Nevertheless, barefooted dipodils and gerbils with partially furred soles are commonly found on sandy substrates.

Animal coloration has continued to be the subject of much study and speculation. In essence, color in animals serves the function of mimicry, camouflage, communication, and modification of the effects of thermal radiation. Cryptic coloration serves particularly well as

camouflage in Egyptian deserts because the vegetation is sparse, providing little cover for desert animals (Louw and Seely 1982). Color also aids in thermal regulation, but it is not the only factor that determines the rate of absorption or reflectance of radiation. The physical nature of the pelage or plumage also affects the optical properties of these structures.

Order: Lagomorpha
Family: Leporidae
Species: Lepus cf. capensis -hara, arnab, hare

Site 2 material: 1 left scapula; 1 right innominate; 1 left innominate; 1 proximal metapodial. NISP=4.

Lepus capensis is found throughout Egypt and it is the only hare known from this area. Consequently, elements identified as hare are referred to as Lepus cf. capensis. It has been reported to prefer the vegetated deserts and wadi mouths along the Red Sea, Gulf of Suez, and western Mediterranean coast. In the area of Bir Abraq, hares were found hiding in rock crevices (Hoogstraal et al. 1957ab). In the Western Mediterranean Coastal Desert hares spend the day in clumps of Lycium sp. At Zeitum, Siwa Oasis, hares were found in Tamarix sp. (Osborn and Helmy 1980). South of Quena hares were seen in Zygophyllum coccineum (desert shrublet) and near Bir Zafarana in the Eastern Desert, they were observed in Juncus sp. (rush) (Osborn and Helmy 1980). Wassif (1953) reported hares from stands of Panicum turgidum (perennial grass) in wadis in the Risan Eineiza area of north Sinai Peninsula. Setzer (1956) noted hares in the Sudan were very common and inhabited the open savanna scrub.

Little is known of the plants eaten by hares in Egypt. The variety is doubtlessly great (Osborn and Helmy 1980). Tregenza (1958) noted

that they gnawed the bark of yassar trees (Moringa peregrina); Bedouins say that they eat fallen acacia blossoms, and Osborn and Helmy (1980) report that they have witnessed hares nibbling Zygophyllum coccineum.

Order: Carnivora
Family: Canidae

Site 1 material: 1 phalanx. NISP=1.

Site 2 material: 1 axis. NISP=1.

Genus: Canis spp.

Site 1 material: 1 right mandible. NISP=1.

Site 2 material: 1 left mandibular alveolis; 1 unsided mandibular alveolis; 2 left scapulae; 1 left astragalus; 1 left metatarsal (II); 1 right metatarsal (IV); 1 left metatarsal (V); 1 phalanx II. NISP=9.

Canis aureus, the jackal, with the exception of its dorsal main, resembles a large dark yellow dog. The skull is very dog-like and many large dog skulls have been deposited in museums and mistakenly labeled as "jackals" (Osborn and Helmy 1980). Because no single osteological character can be used to separate dog from jackal (cf. Osborn and Helmy 1980), material recovered from the Fayum are referred to as Canis spp.

Jackals living near the Nile Valley and Delta are reputed to feed on cultivated crops and to prey upon domestic animals. Howell (1956) noted that in Wadi Gazzah (northwest Sinai), jackals entered camps and villages to eat chickens, young goats, and sheep. Although some authors consider the jackal a scavenger (e.g., Setzer 1952; Hoogstraal 1964a; Dorst 1970), there is evidence to indicate that they are opportunistic feeders. Stomach contents of a jackal trapped near Bir Shaqq contained shell fragments of desert snails, gazelle remains, and wings of moths (Osborn and Helmy 1980). In the Fayum, Anderson (1902) reported that

they lived on fish that were easily caught in shallow water areas of the lake. Jackals are also reported to eat dates, mulberries, and other fruits when in season (Osborn and Helmy 1980).

Genus: Vulpes sp. -taaleb

Site 1 material: 1 calcaneum. NISP=1.

Two species of fox inhabit the Western Desert, V. vulpes and V. rueppelli. Due to the fragmentary nature of the recovered element specific identification was not possible.

The Nile Fox, V. vulpes, has been reported from the Fayum. In the desert it is found in vegetated wadis, while those living in the Nile Valley inhabit date and fruit groves, cultivated areas, and even suburban gardens. Vulpes vulpes is not strictly nocturnal and is commonly seen during the daylight hours. Stomach contents examined by Osborn and Helmy (1980) consisted of figs, various plant remains, bread, and bird and rodent remains. Flower (1932) reported one with its stomach full of mole crickets. The availability of water may be the factor limiting its distribution to oases and the Nile valley.

The sand fox (Vulpes rueppelli) also is an inhabitant of the Western desert and they can always be found in the vicinity of springs and shallow wells (Osborn and Helmy 1980). Tracks have also been reported long distances from water (Hurst 1910) and Osborn and Helmy (1980) collected specimens in waterless areas. It may be possible that this fox can utilize brackish water.

Sand foxes are reported to eat rodents, small birds, lizards, insects, and dates. Hoogstraal (1964a) found that in the Sinai a camel

carcass was an attraction to sand foxes. Tregenza (1958) remarked on the ability of this animal to climb trees.

Order: Artiodactyla
Family: Bovidae
Genus: Gazella spp. -Ghazal, Reem

Site 1 material: 1 left horn core; 1 right maxilla; 1 m2; 1 m3; 1 right scapula (head); 1 left scapula (head); 1 left humerus; 1 left distal humerus; 1 right radius; 1 left proximal radius; 2 left radii; 1 right metacarpal; 1 left tibia; 2 left metatarsals; 1 phalanx I; 1 phalanx II; 1 phalanx; 2 atlas. NISP=21.

Site 2 material: 1 right horn core; 3 unsided horn core fragments; 1 left mandible; 1 left proximal femur; 1 patella; 1 right distal tibia; 1 left distal tibia; 1 astragalus. NISP=10.

Site 3 material: 1 horn core; 1 astragalus. NISP = 2.

Two species of gazelle, Gazella leptoceros and G. dorcas, currently inhabit Egypt, although other species may have been present in the past.

The presence of G. leptoceros (Reem, Ghazal, Abyad) appears to be closely correlated with areas between dunes which support shrubbery (Cornulaca monocantha), in depressions with stands of Acacia raddiana, and with sandy areas bordering oases supporting Nitraria retusa (desert shrublet). The general opinion on the preferred habitat of G. leptoceros from observations in Algeria (Loder 1894; Thomas 1894; Pease 1896), Tunisia (Schomber and Kock 1960), and Egypt (Hoogstraal 1964a) is that this animal lives almost exclusively in sandy areas or dunes. Although not strictly a sand Gazelle in Egypt, it has never been reported from the Mediterranean Coastal Desert where G. dorcas still occurs. This evidence might suggest that it is a more desert inhabiting species than G. dorcas. Flowers (1932) states that G. leptoceros existed although not abundantly in the desert west of Giza (Western Desert) which

stretches from Wadi Natroum southward to the Fayum. There is no evidence, however, that G. leptoceros still occupies this area.

Nitraria retusa, a shrub of saline sandy areas bordering oases, is a staple food of gazelles in the northern part of the Western Desert (Osborn and Helmy 1980). Stomach contents of G. leptoceros included remains of Cornulaca monocantha and Launaea capitata. Gazella leptoceros has been found together with G. dorcas and flushed from the same groves. Gazella leptoceros probably feeds on acacia as does G. dorcas (Osborn and Helmy 1980). Nothing is known of the water economy of G. leptoceros. Osborn and Helmy (1980) have observed it drinking at Wadi Muwellih.

Gazella dorcas (Afri, Ghazal) can be found in the Western Desert on sandy and hard desert substrates, margins of oasis, wadis, and canyons in cliffs or mountain areas.

Observations made by Cloudsley-Thompson and Ghobrial (1965) in the vicinity of Khartoum, Sudan indicate that G. dorcas inhabits areas where some water, fresh or saline, or dew or succulent plants are available or can be attained by travelling. Captive gazelles deprived of water were able to survive 12 days in winter and 5 days in summer in Khartoum (Ghobrial and Cloudsley-Thompson 1966), withstanding a weightloss of 17-20% (Ghobrial 1976).

Carlisle and Ghobrial (1968) noted that during the dry season dorcas gazelles ate only Acacia tortilis leaves, which contain 60% moisture. Grasses, twigs, bark, and green shrubs were ignored. In the western Desert, Nitraria retusa is a staple food. Pods of Acacia raddiana were

recovered from the stomach of a specimen taken at Tahl el Fawakhir near Qara. Fragments of Moltkiopsis ciliata, Anabasis articulata, and Suaeda sp. (succulent halfshrubs) were found in G. dorcas from the vicinity of Qaret el Mashruka. Careful examination of a gazelle feeding area revealed no evidence that grass was eaten by G. dorcas (Osborn and Helmy 1980).

Species: cf. Alcelaphus buselaphus -Begra el Ouash, Bubal

Elements of several large antelope were recovered from the Fayum. Material that compared to Alcelaphus in reference to both morphology and osteometrics are reported herein.

Site 1 material: 1 right maxilla; 1 right scapula (head); 1 right radius; 1 right metacarpal; 1 left navicular; 1 right calcaneum; 2 phalanx II; 1 phalanx. NISP=9.

Site 2 material: 1 right astragalus. NISP=1.

Site 3 material: 1 left ulna; 1 left disal tibia; 1 right distal tibia. NISP=3.

The hartebeest has been extirpated from Egypt. It has been reported historically from oases and oases-like depressions of the Western Desert and Western Mediterranean Coastal Desert. Sonnini (1807) spoke of herds of 8 to 10 animals, probably hartebeest, and mentions that the Arabs hunted them. He also stated that he had seen them domesticated by the Bedouins. Anderson (1902) wrote that Dr. R. C. Mitchell had been told by Bedouins of the Fayum that hartebeest could be found two days journey by camel due west of Birket Qarun, roughly 80-100 km. In 1965, a Bedouin in Salum mentioned having seen a "wild cow" about 30 years before in Siwa Oasis. Jennison (1937) believes that hartebeest were once common all along the North African coast because of the trading in these

animals during Roman times. Hartebeest were among the animals displayed in Alexadria during the reign of Ptolemy III (283-246 BC) (Jennison 1937). Indefinite as these reports appear, some of the sitings must surely have been hartebeest. Within historical times, the hartebeest no doubt existed in vegetated areas of the Western Desert (cf. Osborn and Helmy 1980).

There are no known recent specimens from Egypt although mummified remains from El Abadiyah, El Fayum, and Sakkara have been reported (Anderson 1902; Loret and Gaillard 1908; Blain 1914). Also, the tombs and temples of ancient Egypt are adorned with figures of hartebeest (personal observation). Pleistocene fossil fragments are also known from Kom Ombo and Wadi Halfa (Reed and Turnbull 1969).

Genus: cf. Ovis/Capra spp.

Site 1 material: 1 occipital/parietal/frontal; 2 left maxillae; 1 p3; 1 right p4; 2 unsided p4; 3 m1; 2 right m2; 4 left m2; 1 unsided m2; 2 right m3; 5 left m3; 2 unsided m3; 3 molariform teeth fragments; 11 right mandibles; 15 left mandibles; 1 unsided mandible; 1 mandibular condyle; 1 mandibular coronoid process; 2 right scapulae; 1 left scapula; 9 right humeri; 6 left distal humeri; 1 right ulna; 3 left proximal ulnae; 2 right proximal radii; 3 right distal radii; 1 left distal radius; 3 right metacarpals; 1 left proximal metacarpal; 2 left distal metacarpals; 1 right acetabulum; 1 left illium; 1 right ischium; 1 right proximal femur; 9 right tibiae; 19 left distal tibiae; 6 right astragali; 4 left astragali; 3 right calcanea; 1 left calcaneum; 3 left distal metatarsals; 4 left metatarsals; 1 right metapodial; 1 left distal metapodial; 1 distal unsided metapodial; 1 right phalanx I. NISP=149.

Site 3 material: 1 basioccipital; 1 left distal tibia; 1 unsided distal tibia. NISP=3.

Although it is the impression of this author that the identified materials listed above represent the genus Ovis, knowledge concerning the morphology of Egypt's early domestic sheep and goats is very

limited. Consequently, all remains have been referred to as Ovis/ Capra. Materials referred to as sheep/goat were found to resemble known domestic varieties in general morphology. Osteometrics corresponded to sheep and goat identified from other Neolithic sites in Egypt (cf. Gautier 1976, 1980) (see Appendix A). Additionally, Ammotragus lervia, the barbary sheep, has only been reported twice from this area (1875 and 1902) (Osborn and Helmy 1980) and was probably never plentiful. Its preferred terrain is in the rugged Red Sea mountains east of the Nile and in the rugged areas to the south of the Fayum in the central and southern portions of the Western Desert. Capra ibex (ibex) has never been recorded east of the Nile; populations of ibex still exist in the Eastern Desert.

Genus: Bos spp.

Site 1 material: 1 right maxilla; 1 right p4; 1 unsided p4; 1 right premolar; 3 unsided premolars; 1 right m1; 1 left m1; 1 unsided m1; 2 right m2; 2 left m2; 2 right m3; 2 left m3; 1 unsided m3; 4 molariform fragments; 2 left mandibular condyles; 1 left proximal radius; 1 right metacarpal; 2 right distal metacarpals; 2 left proximal metacarpals; 1 left metacarpal; 1 left tibia; 1 right navicular; 1 left navicular; 1 unsided navicular; 2 left astragali; 1 unsided astragalus; 2 left calcanea; 1 left metapodial; 1 distal metapodial; 1 right phalanx II; 1 left phalanx II; 1 unsided phalanx II; 1 left proximal phalanx; 1 unsided phalanx; 1 thoracic vertebra; 1 lumbar vertebra; 1 vertebral neural arch. NISP=51.

Site 2 material: 1 isolated m3; 1 scapula (head); 1 distal tibia; 1 proximal metapodial fragment. NISP=4.

Site 3 material: 1 right proximal ulna; 1 navicular. NISP=2.

One of the questions facing faunal analyists in Egypt concerns the indigenous nature of some of the domestic bovids. Bos is considered by some to have been locally domesticated. Sample sizes and preservation

of recovered elements, however, limited the current study to referring elements of this genus as Bos spp.

Genus: Ovis, Capra, or Gazella

Site 1 material: 1 incisor; 1 molariform; 1 left mandible; 1 right mandibular condyle; 2 unsided mandibular condyles; 1 right scapula; 1 left scapula; 2 unsided scapulae (head fragments); 1 right humerus; 4 left distal humeri; 1 left medial humerus; 1 medial humerus; 2 right ulnae; 2 left proximal ulnae; 2 right radii; 1 left proximal radius; 2 medial radii; 2 right metacarpals; 1 left proximal metacarpal; 2 left carpals; 1 left acetabulum; 1 right acetabulum; 1 left illium; 1 unsided illium; 1 right ischium; 1 unsided ischium; 1 illium/ ischium; 1 pubis/ acetabulum; 3 right tibiae; 2 left distal tibiae; 1 left astragalus; 1 calcaneum; 1 navicular; 2 medial metatarsals; 10 metapodials; 2 right phalanx I; 1 left phalanx I; 1 phalanx II; 3 unsided phalanges; 1 axis; 2 atlas; 2 cervical vertabrae; 3 thoracic vertebrae; 1 lumbar vertebrae; 1 caudal (first) vertebra; 2 vertebrae fragments. NISP=78.

Site 2 material: 1 scapula (head); 1 right distal humerus; 2 cervical vertebrae; 1 thoracic vertebra; 1 phalanx I. NISP=6.

Site 3 material: 1 left distal humerus; 1 phalanx. NISP=2.

Family: Bovidae

Site 1 material: 1 left maxilla; 1 right P4; 2 premolars; 3 molariform fragments; 30 tooth fragments; 4 distal humeri; 4 ribs; 2 left femora; 1 maleoulus; 3 metapodials; 1 left phalanx I; 1 phalanx III; 2 right phalanges; 2 left phalanges; 2 axis; 2 thoracic vertebrae; 3 vertebrae fragments. NISP=65.

Site 2 material: 25 tooth fragments; 1 coronoid process (ulna); 1 thoracic vertebra. NISP=27.

Site 3 material: 13 tooth fragments; 2 horn core fragements; 1 right ulna. NISP=16.

Discussion

Grayson (1979, 1983, 1984) has presented a convincing argument questioning the validity of the measures of taxonomic abundance (i.e., the minimum number of individuals or MNI and the number of identified

specimens or NISP) commonly employed by faunal analysts. His argument centers on the unknowable relationship between these measures and the actual prehistoric faunal assemblage under study. Additionally, Grayson has noted that measures of abundance based on MNI change with the size of the aggregative unit employed. These changes were shown not to be equal in magnitude nor direction (see Grayson 1979, 1984). That is to say, if Taxon A was two times more abundant than Taxon B using one method of aggregation, it is not likely to be two times as abundant using different aggregative methods. It is even possible, based on MNI, that taxon B, depending upon the aggregative units employed, could be depicted as more abundant than taxon A (for further discussion see Grayson 1984).

Any measure of taxonomic abundance based on MNI consequently provides a rather dubious figure when presented as a ratio scale of measurement. However, a convincing argument might be created by utilizing NISP values obtained from multiple faunal records collected from a single geographic region (Grayson 1982). The justification for this premise is analogous to statistical inferences and their applicability in describing population parameters. Multiple samples taken from a population have a higher probability of reflecting actual conditions concerning the target population than does a single sample. That is, conclusions drawn from a series of samples are less likely to represent conditions deviating greatly from those of the actual population. Additionally, by employing NISP values, problems concerning changing MNI values through the use of different aggregative methods can be avoided.

Thus, samples taken from different Fayum A and B assemblages should provide a test of reliability for the measures of taxonomic abundance employed (NISP), thereby insuring reasonable approximations concerning differences in abundances of the various taxa utilized by Fayum inhabitants.

If different Fayum A occupation areas served similar functional roles, faunal samples taken from those sites should reflect similar relative taxonomic abundances. It would be difficult to attribute similarities across several sites to factors of mere chance. If relative abundances differ across samples, either the sites had different functions or the units of measurement employed are unreliable. Figure 34 shows the location of five sites used in this analysis.

Measuring taxonomic abundance can be carried out at several different scales or levels: ratio, ordinal, or nominal. However, as Grayson (1984) has pointed out, the validity in treating MNI values as ratio scale measurements is doubtful for most cases. A ratio scale measurement requires that differences between measured values reflect actual conditions. That is, if taxon A had an NISP of 20 and taxon B 10, taxon A should be interpreted as being twice as abundant as taxon B. Furthermore, the only sort of transformation permissible for values measured at this scale is the "unit" of measurement employed. Magnitudes between measured entities should not change if the data is transformed into another unit measured at the ratio level. Unfortunately, magnitudes between measurements based on NISP when transformed to MNI clearly

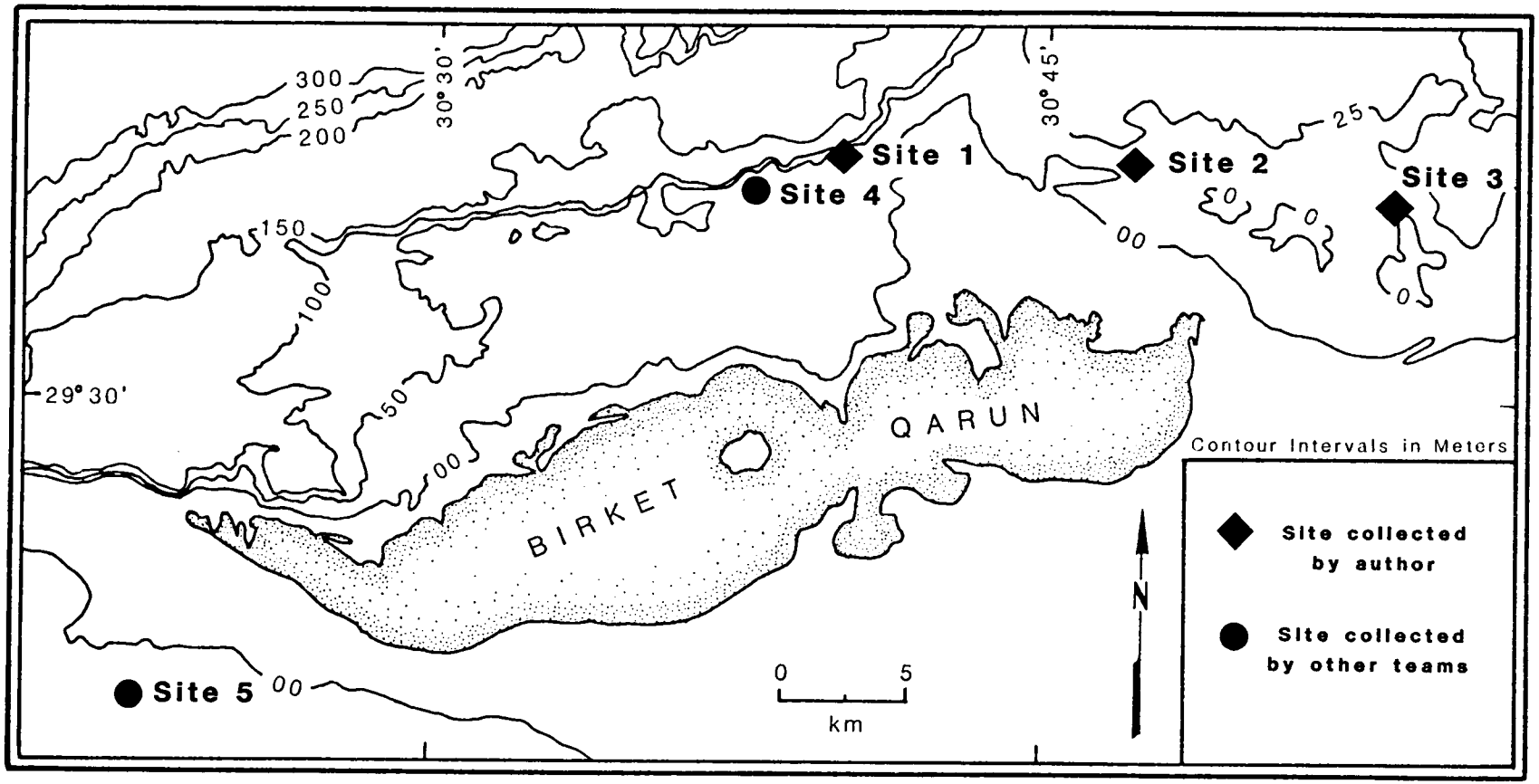


Figure 34. Location of sites used in analysis.

do not remain constant, invalidating the use of the ratio scale for both measures of taxonomic abundance.

Ordinal level measurements, on the other hand, do not require that magnitudes between measured items be factual. Ordinal measures allow one to say that a measured quantity is greater than or less than another but how much the entities truly differ on the property being measured is unknown. Because ordinal measures do not require that differences between ranked items remain constant, using such measurments may provide a valid measure of taxonomic abundance. Consequntly, given similar site funtions, if taxonomic abundance measured at the ordinal level across all Fayum sites were to be in concordance, it is very likely that the ordinal rankings reflect some real value of abundance.

Pisces represents the most abundant vertebrate class identified from both Fayum A and B sites. Large numbers of identified elements belonging to representatives of this class across all sites minimizes potential problems regarding insufficient sample sizes providing, statistically speaking, the best set of data for establishing the validity of the measures to be employed.

Relative frequencies and rank orders of the identified Fayum ichthyofauna are presented in Figure 35. From this it can be seen that ordinal rankings appear to be similar at all sites. Kendell's Coefficient of Concordance was employed to substantiate this observation. The Kendell's Coefficient is computed by organizing the data into five rows representing the five different sites analyzed and seven columns representing the different taxa. It should be noted that only potential

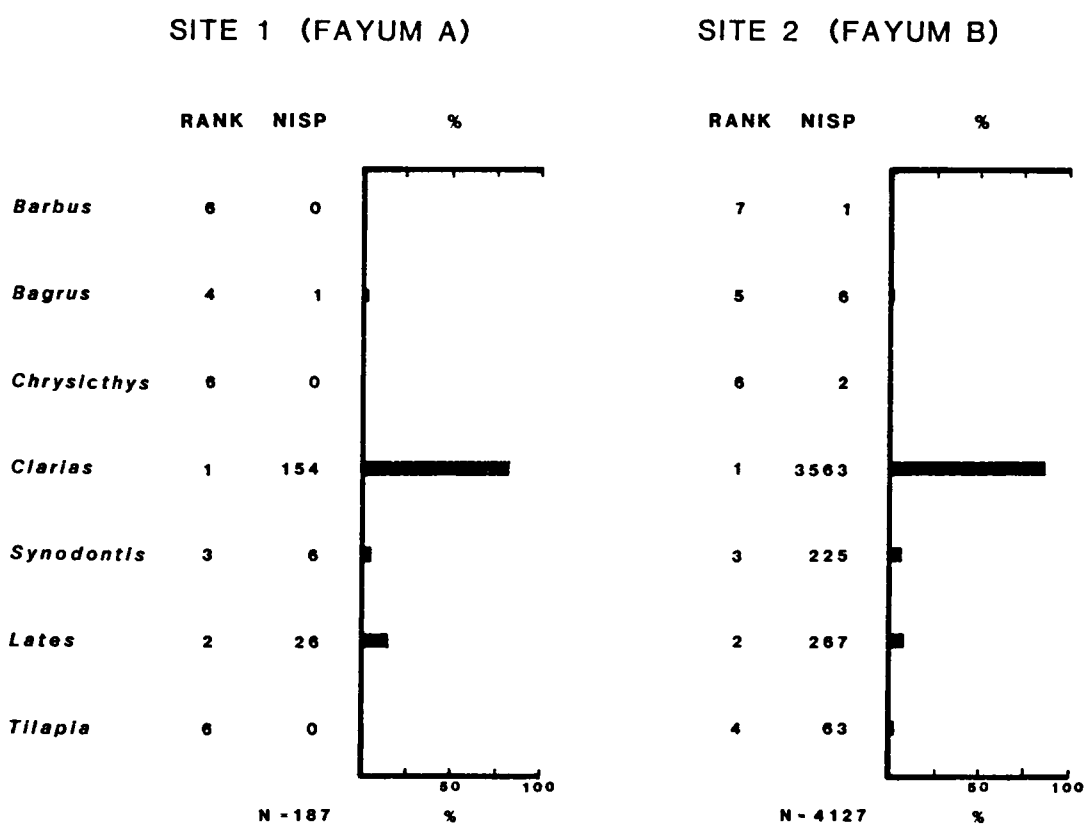


Figure 35. Relative frequencies and rank order of Fayum ichthyofauna.

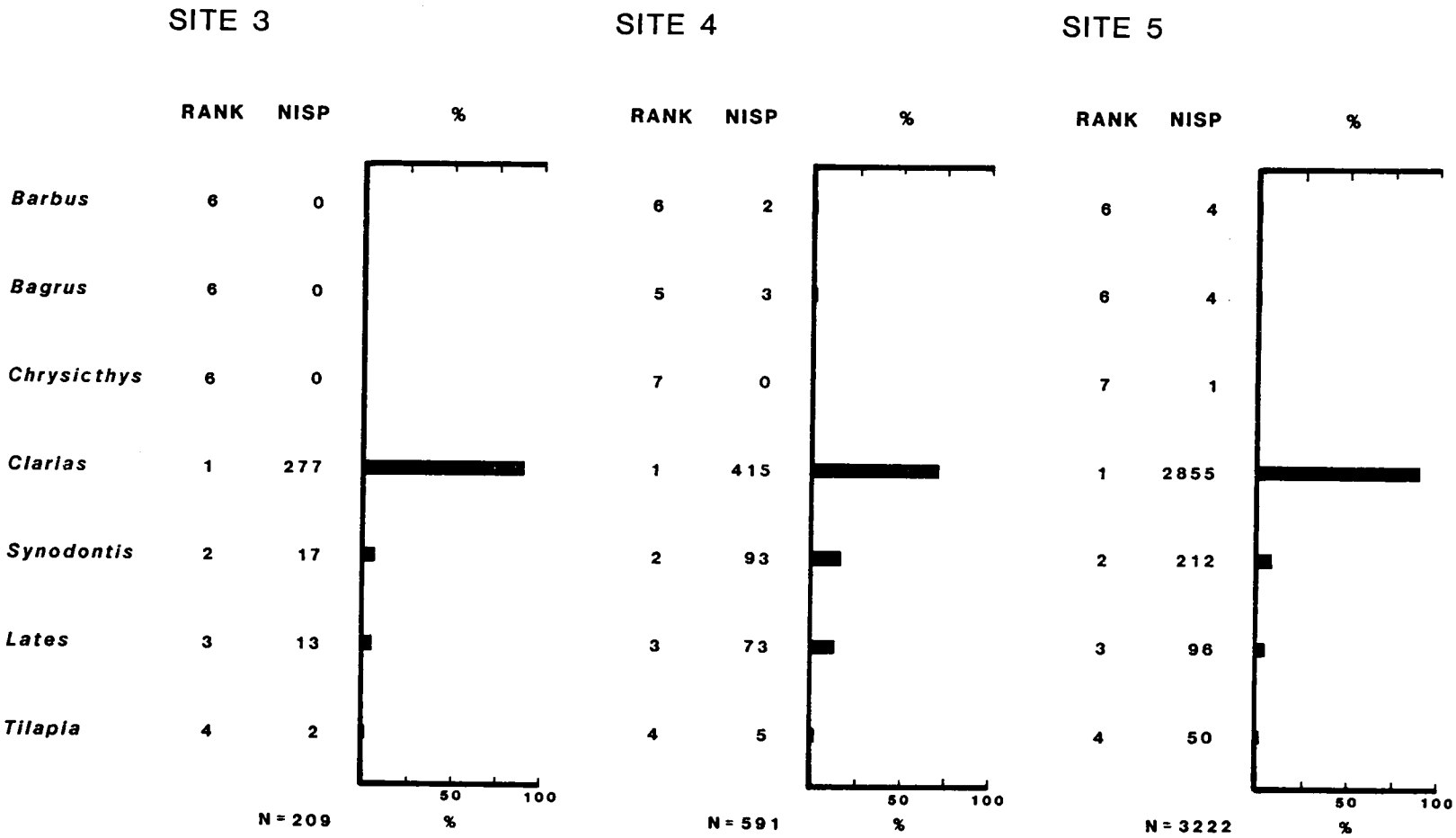


Figure 35 (continued)

food species are presented, Tetraodon is poisonous (Rivallain and Van Neer 1983) and consequently its remains are not considered to represent subsistence activities (i.e., similar site fuction). Furthermore, in only one site (Site 5) was Tetraodon abundant. Fauna from this site, however, was not identified by this author. Consequently, this anomaly, regarding Tetraodon, could not be verified.

If the Fayum fauna were present in the same rank order across all sites, one column total should be equal to five, another to ten and so on with the largest column total equal to 35. This would result in a concordance value of 1.0. On the other hand, if no tendancies in the rankings were to exist, each column total would be equal. The resulting concordance value would then be 0.0. The test when applied to the Fayum ichthyofauna (Table 5) shows column sums of ranks to be unequal, demonstrating the existence of a certain amount of agreement in taxonomic rankings across sites. The computed value was .895 depicting a very high degree of concordance between taxonomic rankings of the Fayum ichthyofauna. This suggests that the measures of taxonomic abundance employed reflect some real value and these values in turn suggest a similar utilization of Birket Qarun's ichthyofauna across sites.

Results

Identified mammalian materials from Site 1 (Fayum A) (Figure 36) show a heavy utilization of domestic animals. Site 2 (Fayum B) lacks domesticates but the presence of wild ungulates identified from this assemblage suggests Fayum B inhabitants practiced large game hunting. Compiled evidence from other Fayum A sites (Figure 37) also shows a

Table 5. Kendall's coefficient of concordance for the Fayum ichthyofauna.

	Ordinal Rank of Taxa						
Site	Barbus	Bagrus	Chrysicthys	Clarias	Synodontis	Lates	Tilapia
1	6	4	6	1	3	2	6
2	7	5	6	1	3	2	4
3	6	6	6	1	2	3	4
4	6	5	7	1	2	3	4
5	5.5	5.5	7	1	2	3	4
Tj	30.5	25.5	32	5	12	13	22

$$W = \left(\frac{12\Sigma T_j^2}{m^2 n(n^2 - 1)}\right) - \frac{3(n + 1)}{n - 1} = \frac{41118}{8400} - 4 = .895$$

W = Kendall's W statistic,

T_j = sum total of ranks per column,

m = number of rows (sites), and

n = number of columns (taxa).

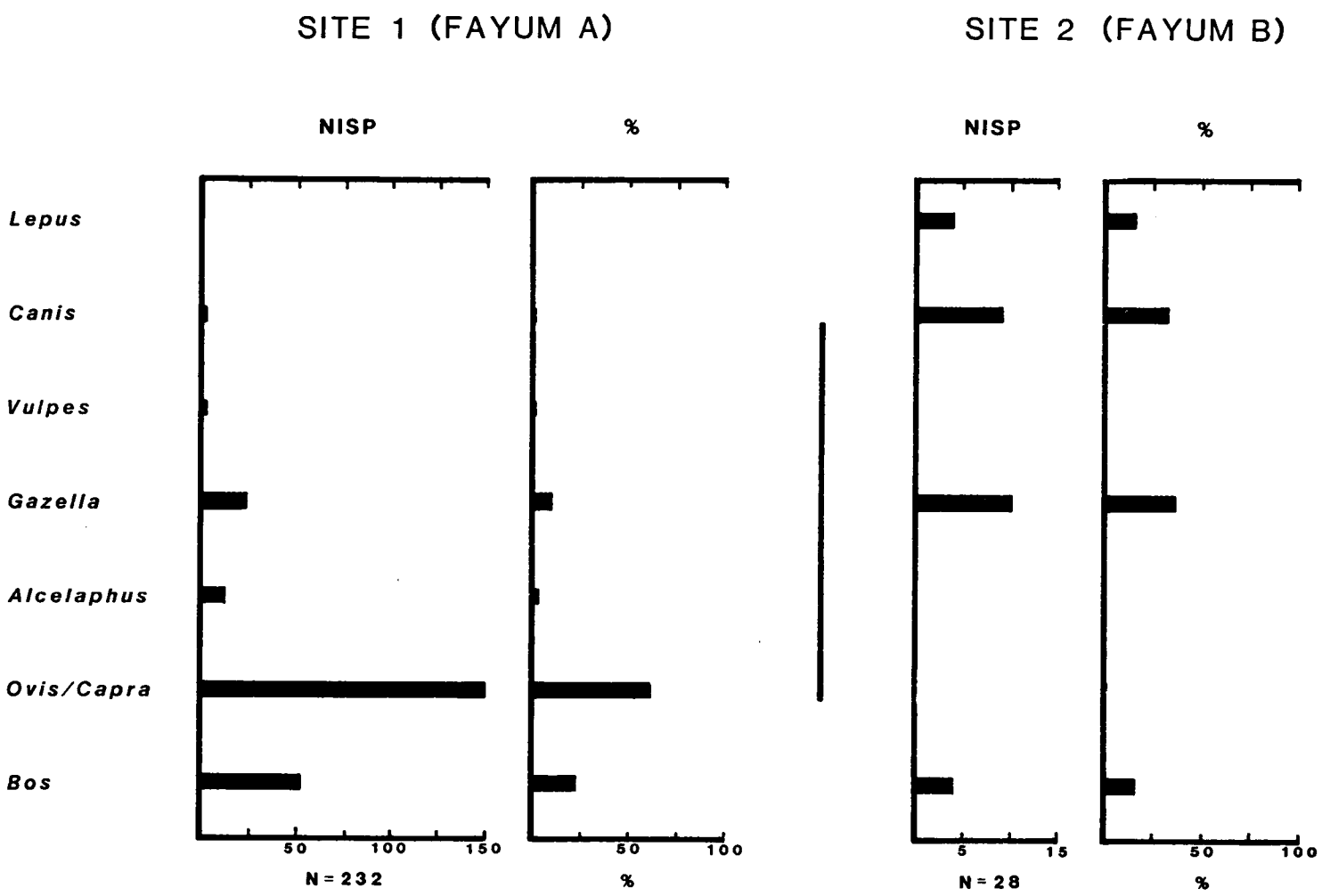


Figure 36. Relative frequencies and NISP for Site 1 (Fayum A) and Site 2 (Fayum B) mammalian faunas.

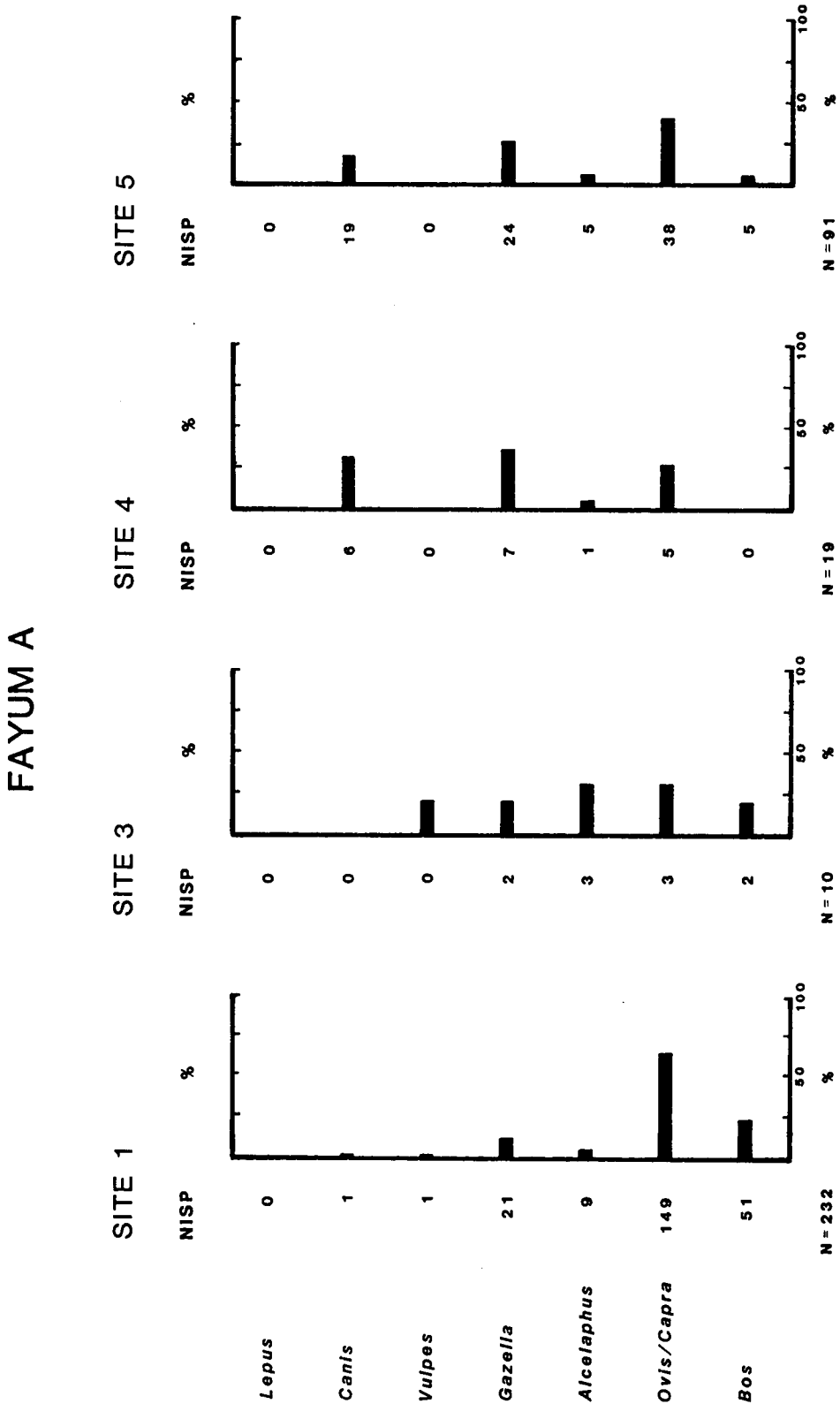


Figure 37. NISP and relative frequencies for identified mammals from Fayum A sites.

utilization of domesticates but, when compared to Site 1, domesticates appear in greatly reduced frequencies. It should be cautioned, however, that measures of differences in magnitude between taxa have not been substantiated as valid. Nevertheless, one can infer that domesticates were not the sole source of animal protein for Fayum A people and that, in fact, other sources were utilized and perhaps heavily utilized at particular times of the year. Minimally, the mammalian evidence suggests that both Fayum A and B cultural groups took advantage of the area's wild terrestrial animal resources.

Fish, more closely related to the lacustrine environment, depict an interesting set of conditions. Referring to the two main sites investigated, Site 1 and Site 2, it appears that the same fish taxa were utilized and in similar relative abundances (Figure 38). That is, Clarias, which prefers shallow deoxygentated water, is the most abundant aquatic animal represented. This would tend to support the premise that shallow water habitats were important to both cultures. Also found in large numbers are the remains of nile perch, Lates niloticus. Lates, however, inhabits deeper more oxygentated waters than Clarias and seldom if ever ventures into shallow water areas (Van Neer 1984).

The most effective way to exploit both taxa would be to utilized separate procurement strategies; shallow water Clarias collecting and deep water Lates fishing. The term collecting is used with reference to Clarias because these fish reach sizes of tremendous proportions and living in shallow water they can be readily seen and effectively hunted by spearing or netting. Greenwood and Todd (1970) and Bruton (1979) state that during the spawning season Clarias can be caught by hand.

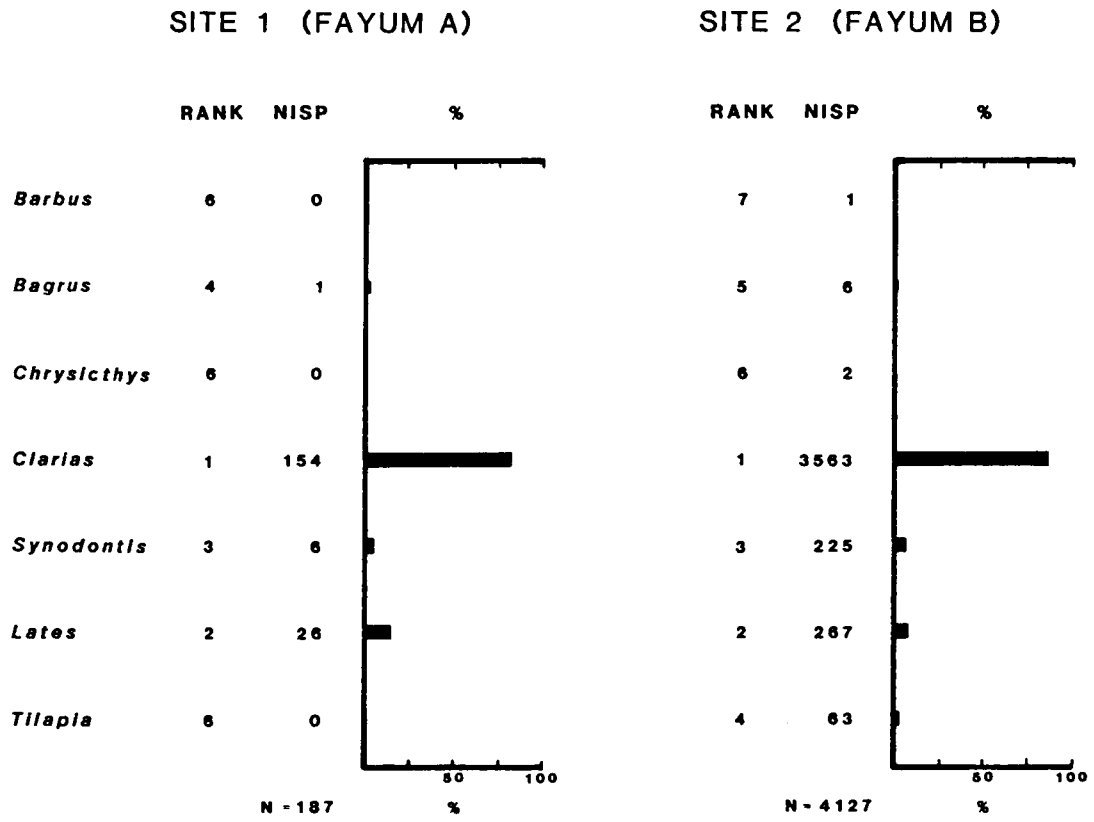


Figure 38. NISP, relative frequencies, and rank order of Site 1 (Fayum A) and Site 2 (Fayum B) ichthyofauna.

Lates, on the other hand, preferring deep water, would be collected most effectively only by netting or angling in the open, deep waters of prehistoric Lake Qarun.

If this dual procurement strategy were practiced one would expect to see few shallow water taxa other than Clarias represented in the archaeological record. A deep water fishing strategy, however, would not be as selective and thus the archaeological record should depict larger numbers of several different deep water taxa.

Examination of identified specimens from all five sites (Figure 39) show a large discrepancy between Clarias and other shallow water taxa. Clarias is represented by the greatest number of identified elements. Tilapia, also a shallow water fish, is represented by very few elements or sometimes it was not recovered at all. Interestingly, Tilapia is by far the predominant species in terms of numbers of individuals in shallow water areas (personal observation). Deep water taxa such as Lates and Synodontis are present in nearly equal proportions. Although purely speculative, Tilapia may be poorly represented in Fayum A and B sites because Clarias collecting may have been accomplished by netting or spearing individuals or groups that had been intentionally targeted for capture. Tilapia would thus only be caught as a by product of Clarias collecting. Faunal evidence, therefore, suggests that a selective fishing strategy may account for the observed differences in the archaeological faunal assemblage.

If Fayum inhabitants did indeed concentrate on shallow water resources, then one would expect large numbers of birds, known to be associated with shallow water areas, to have been utilized as well.

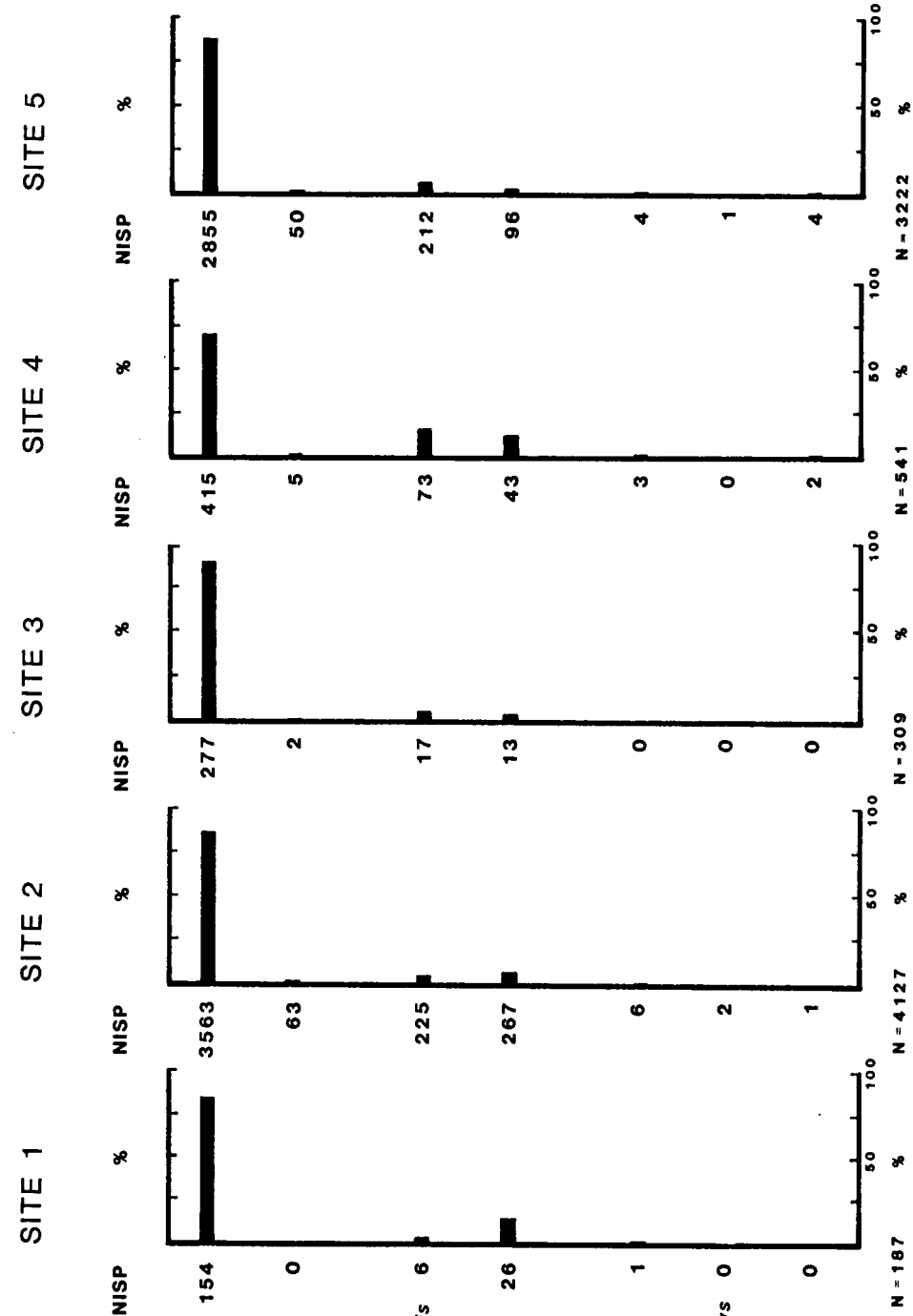


Figure 39. Comparison of deep and shallow water taxa based on NISP and relative frequencies.

Evidence from the avian remains shows that all identified elements recorded, with one exception, were shallow water birds (Table 6). If open deep water birds (such as the Moorhen), which like all inland water birds require fringes of shallow water vegetation, can be included, then all birds recovered from both Fayum A and B sites can be accounted for as having at least some dependence on shallow water areas, and thus would be located at some time in shallow water habitats.

In summary, identifications of the recovered Fayum fauna suggest that both Fayum A and B peoples heavily utilized shallow water areas. Both groups as evidenced by numerous Lates and Synodontis elements, practiced some form of deep water fishing and both groups utilized the native terrestrial fauna of the area as well. Fayum A sites differ from Fayum B sites only in that people of the former utilized domesticates. Relative abundances of domestic taxa, however, differ between sites. While this may be a factor of sampling or sample size, similarities in the relative abundances of the three Fayum A sites (Site 3, 4, and 5) suggest minimally, that the use of domesticates was not the sole source of animal protein and, although speculative, it is possible that other sources were heavily relied upon during certain times of the year.

Table 6. Fayum avian remains.

	Fayum B	Fayum A
Shallow Water		
Podeceps cristatus (Great Crested Grebe)	15	
Ixobrychus minutus (Little Bittern)	1	
Tadorna tadorna (Shelduck)	1	
Anas cf. penelope/strepera/acuta/clypeata (Ducks spp.)	16	10
Anas crecca (Green-Winged Teal)	2	
Porphyrio cf. madagascariensis (Green-backed Gallinule)	1	
Fulica atra (Coot)	11	1
Cygnus cygnus (Swan)		1
Open Water		
Gallinula chloropus (Moorhen)	1	

CHAPTER 4

SEASONALITY ASSESSMENT BASED ON SELECTED FAYUM FAUNAL REMAINS: PISCES: *CLARIAS* AND MIGRATORY BIRDS

Fayum A assemblages are thought to represent a sedentary culture dependent upon domesticates (Caton-Thompson and Gardner 1934; cf. Wendorf and Schild 1976). However, evidence based on the faunal remains gathered from Fayum A and B cultural assemblages suggests a similar reliance by both groups on the areas wild indigenous fauna. Both Fayum A and B inhabitants made extensive use of shallow water resource areas, both practiced some form of deep water fish procurement, and both utilized the terrestrial fauna of the area. If Fayum A inhabitants were indeed sedentary year round occupants, a premise that has never been tested, one would expect to find some evidence in support of this. Because shallow water resources are thought to have played an important role in both Fayum A and B procurement strategies an investigation of the incremental growth structures found on *Clarias* pectoral spines, supplemented by information derived from the seasonal migration of birds, might produce insights regarding the seasonal procurement strategies practiced by the respective cultural entities.

An examination of identified taxa recovered from Fayum A and B sites (Table 4, p. 73, and Figure 39) shows that *Clarias* remains dominate the shallow water faunal assemblage. Because *Clarias* can be collected throughout the year and because large samples were recovered from both Fayum A and B assemblages, an intensive study of the growth cycles of

these fish was undertaken to provide information as to the time of year they were procured. Evidence of a year round collection of Clarias by Fayum A people would serve to strengthen hypotheses regarding their permanency in the Fayum area.

Seasonal analysis based on archaeological fish remains is not without precedent. There exists a large body of literature by which data on incremental growth structures have been presented as a means to age fish (e.g., Marzolf 1955; Lagler 1956; Casteel 1976; Bagenal and Tesch 1978) and to derive seasonal and climatic information (e.g., Morey 1983; Osten 1980; Van Neer ms. in preparation).

Clarias, because it is ectothermic, is dependent upon water temperatures to maintain its metabolic activity. When temperatures are warm as in summer, the fish is active, feeds heavily, and growth is registered on various skeletal elements. During the cold months of the year the fish is relatively inactive, feeds little, and this growth slows dramatically. The period of reduced growth corresponding to the cooler periods of the year is visible in cross sections of certain skeletal elements as a narrow dark zone composed of closely spaced circuli, the outer edge of which is referred to as an annulus or the arrest line (Marzolf 1955). By determining what stage of yearly growth is represented on the outer edge of the skeletal element, the season of death of the fish can be estimated. Undoubtedly many other factors such as population density and local water conditions also affect growth rates to some degree and will effect seasonal estimates by adding a measure of error to the calculations.

Seasonal growth can be measured on several Clarias skeletal elements. However, the pectoral fin spine was chosen for study because it preserves well, it can easily be identified, and large numbers of pectoral spines from modern specimens of Clarias could be collected throughout the year by which to monitor the fish's seasonal growth cycles. Additionaly, because pectoral spines can be readily identified as to whether they are from the right or left side of the fish, and each fish only possesses a single pair of spines, potential problems of basing seasonal estimates on more than one element from a single fish can be eliminated.

Analysis of Growth

Before an attempt could be made to seasonally date prehistoric Clarias pectoral spines, research was needed on modern specimens from which a model for seasonal growth could be constructed and tested. If the model is shown to be reliable, then specimens recovered from archaeological context can be analyzed and the season of death of the fish can be determined. Living specimens of Clarias (107 individuals) were obtained from the Cairo area from September 1983 through August 1984. Spines from these fish were labeled and stored in a compartmentalized tray according to the week in which they were collected.

After sampling had been completed an assistant was told to pick at random three pairs of spines from anywhere on the tray, remove the data-tag from the spines and place the spines in one envelope and the data-tag in a second envelope. No explanation was given to the assistant as

to the purpose of the exercise. On another occasion an assistant was given similar instructions, except this time the spines were to come from adjacent trays. Additionally, researchers working or living in Cairo, Luxor, and El Minya (Figure 40) were asked to collect several pairs of Clarias pectoral spines, keeping the date of collection sealed in an envelope. These spines would serve as a test of reliability once the predictive model had been constructed.

In order to calculate seasonal growth rates it was first necessary to obtain thin-sections from one spine, usually the right, of each pair collected. The point of sectioning was taken at the base of the articulating surfaces (Figure 41). Work done by Marzolf (1955) and Sneed (1951) on North American ictalurids showed that sections from this area consistently show all detectable annuli. Sections taken from more distal areas will not exhibit earlier periods of fish growth. Spines were sectioned on a Metal Research microslice saw; thickness for each section was set at 500 microns. No further treatment of the sections was necessary to view the annual growth structures.

Figure 42 shows a schematic view of a pectoral spine thin-section under natural light conditions. The spine sections when viewed through cross polarized light, which produces a negative image, showed annuli which appeared as continuous, narrow, light bands. These bands reflected the reduced growth during Egypt's cooler winter months. Areas corresponding to the warmer months, representing accelerated growth, were visible as wider, dark areas between the lighter colored annuli. As a

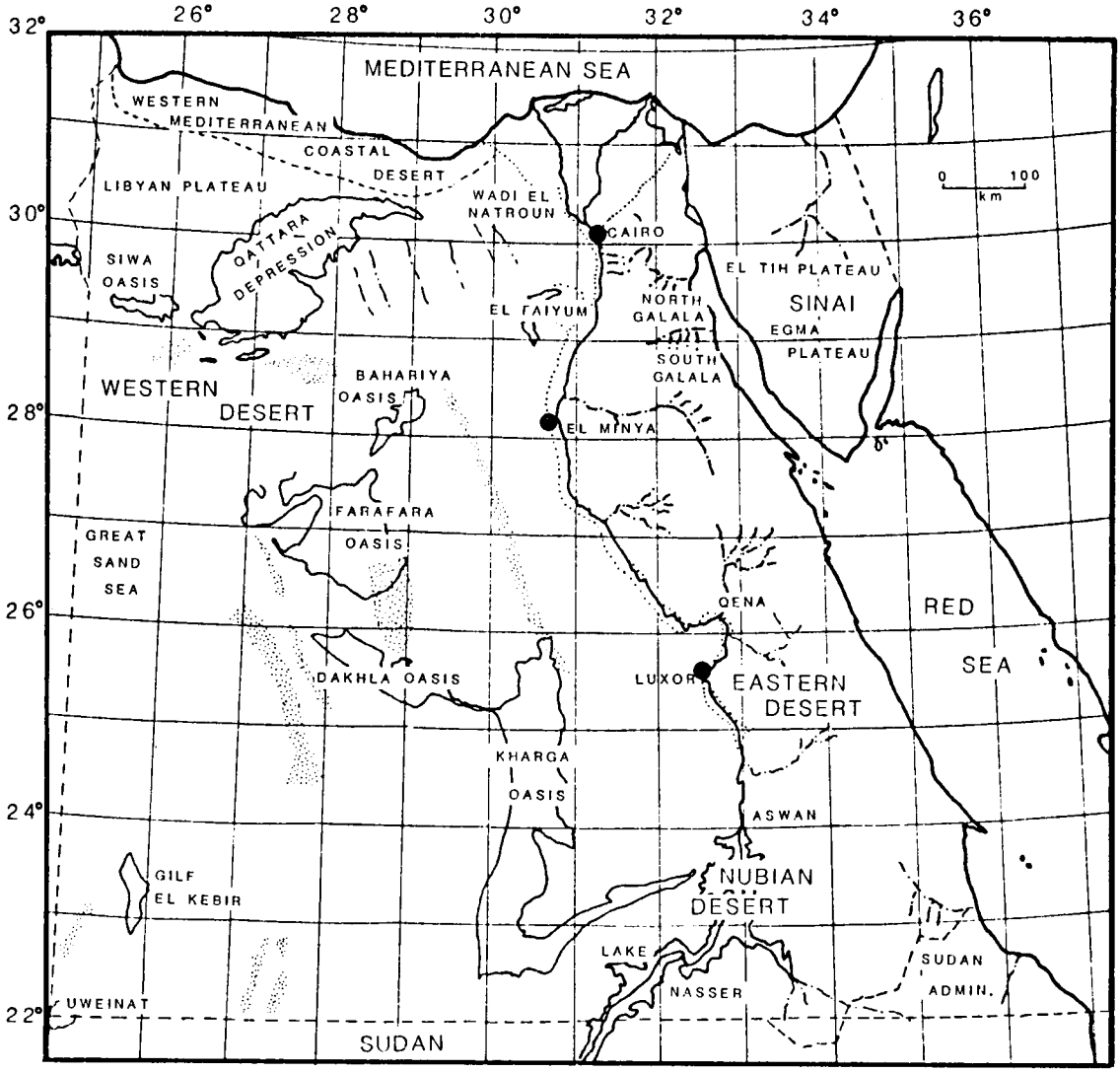


Figure 40. Clarias sampling locations.

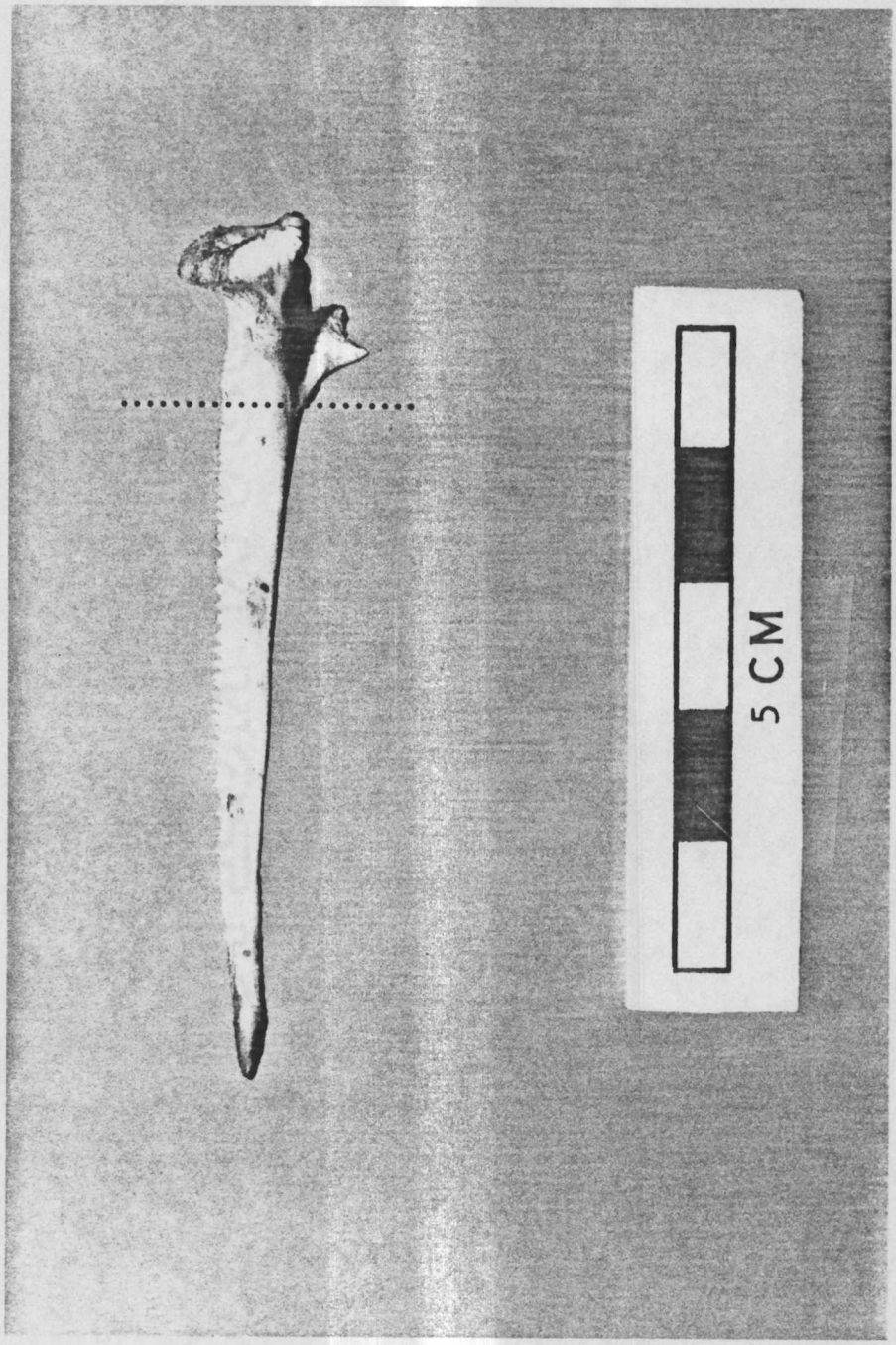


Figure 41. Point of sectioning on Clarias pectoral spine.

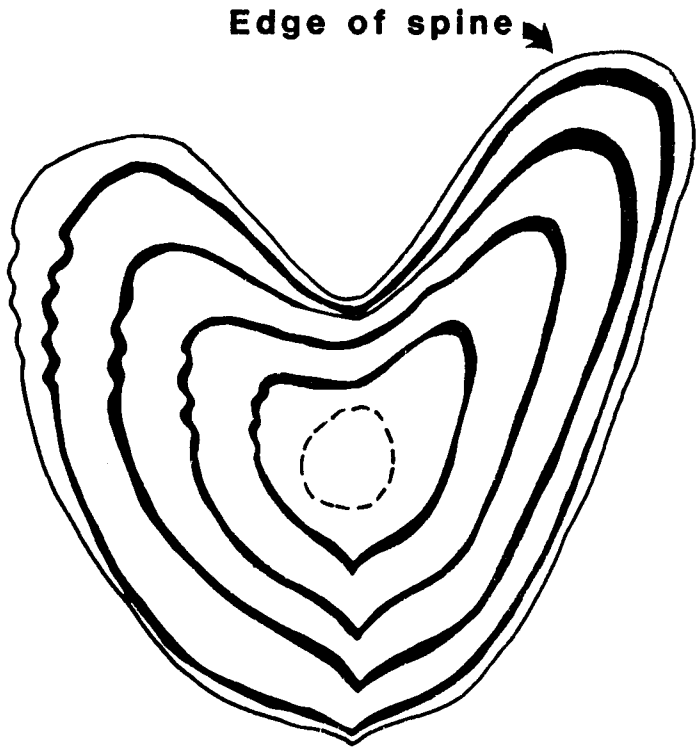


Figure 42. Schematic view of pectoral spine thin section of Clarias.

rule, the transition between annuli and the areas representing accelerated growth were quite distinct (Figure 43).

In order to construct a growth ratio, the distance from the beginning of the last annulus to the edge of the spine (A) was measured and compared with the distance of the last full season of growth (B), the distance between the beginning edge of the last two arrest lines (Figure 44). Measurements were taken from 5 x 7 photographs of each section. Each photograph was taken with the same magnification on the same Ziess cross polarizing microscope. A ratio for growth was constructed by using the final season of growth, truncated by the animals death (A) as the numerator and the last full season of growth (B) the denominator (Figure 44). Growth measured as a percentage of the previous years growth eliminated problems of comparability between spines that would occur if absolute measures were used. Relating the final growth period as an absolute number assumes that the expected growth for each fish is equal per unit of time and across space. This approach neglects to account for natural variability within the species. For example, one specimen of Clarias may measure six units of growth during its final full year of life (B) and three units of growth in its final growth period (A). Another fish taken on the same day from the same area may measure 12 units and six units respectively. Absolute measures lack comparability. However, once converted to a ratio some of the individual variability can be neutralized. In this case both fish register that 50% of this seasons growth had been attained when compared to the total growth of the previous year.

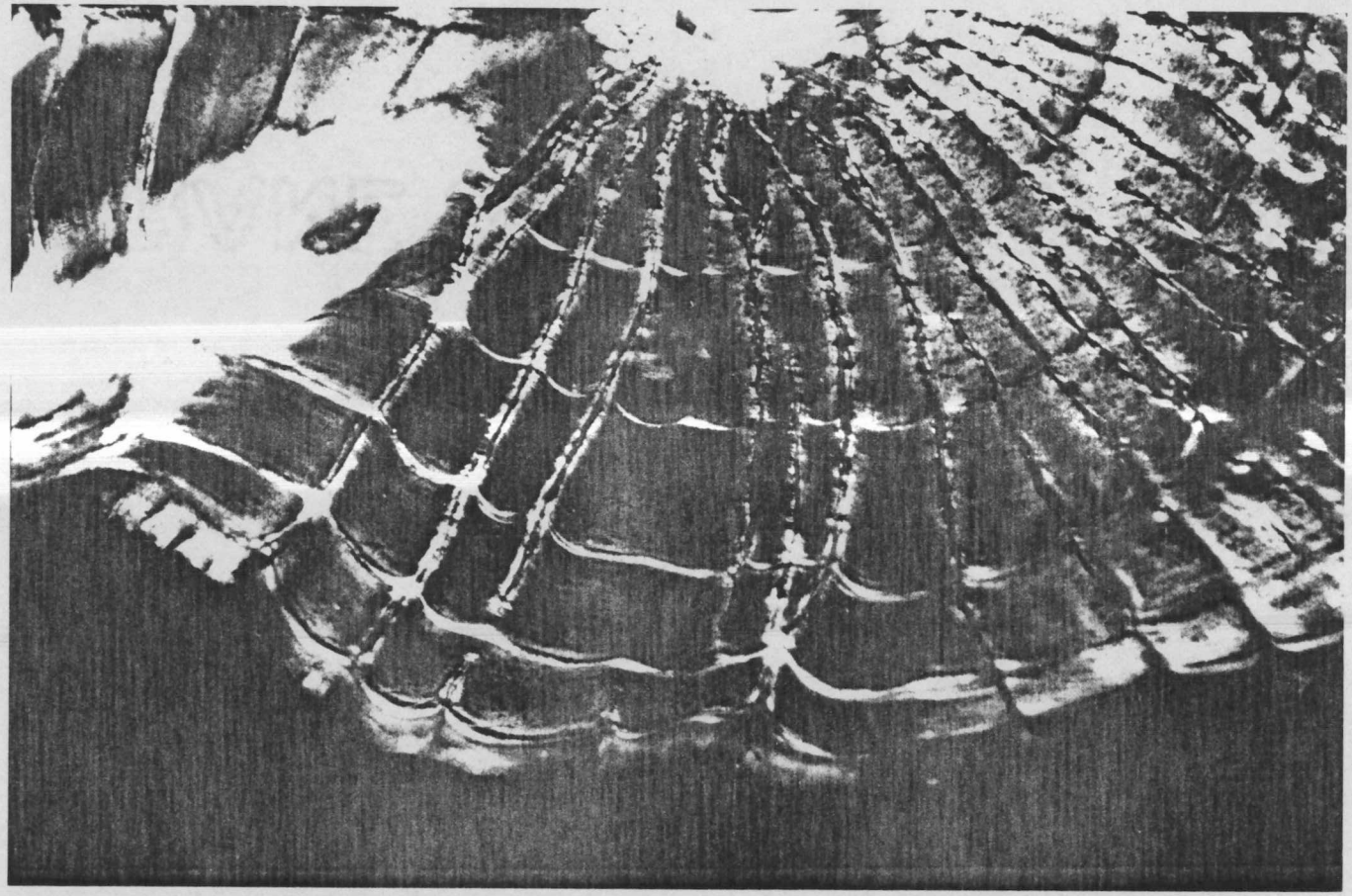


Figure 43. *Clarias* pectoral spine cross-section under cross-polarized light.

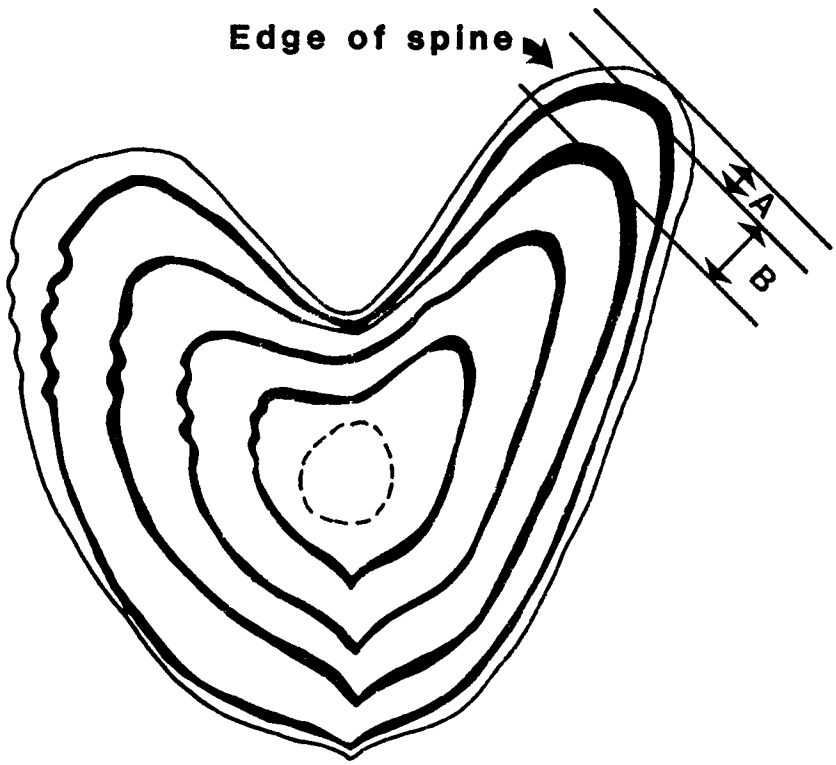


Figure 44. Schematic view of Clarias spine cross-section showing points of measurement.

Each thin section was measured as described above and the growth ratio was computed and associated with the date of the fishes capture. The control group contained 84 separate measurable samples. Overall, approximately 21% (23 pairs) of the modern Clarias spines were rejected due to aberrant irregularities in growth. In most of these cases annuli were not distinct enough to permit accurate measurements. In other cases the specimen was too young to have attained a minimum of one full year of growth.

Occasionally a fish produced an annulus that did not fit the predicted model. That is, an extra annulus was formed in a season other than in the season of reduced temperature (winter). It is likely that this phenomena may have caused other researchers to inaccurately predict seasonal occupations based on Clarias spines (cf. Willem Van Neer, personal communication 1985). Investigations on Clarias obtained in the Luxor area showed that some specimens laid down a false annulus in the late spring-early summer. Specimens of Clarias found to contain eggs during this period were also found to posses a spring arrest line. Analysis of pectoral spine thin-sections from these specimens show that a spring-early summer arrest line is a consistent yearly event (Figure 45). This phenomena has been tentatively attributed to spawning stress. Hashem (1977) reported similar findings based on the analysis of vertebrae from Bagrus bayad attributing the phenomena to spawning as well. Further investigations, however, are necessary to substantiate this finding because not all fish taken at this time period displayed this character, and because the sample taken from this time period was

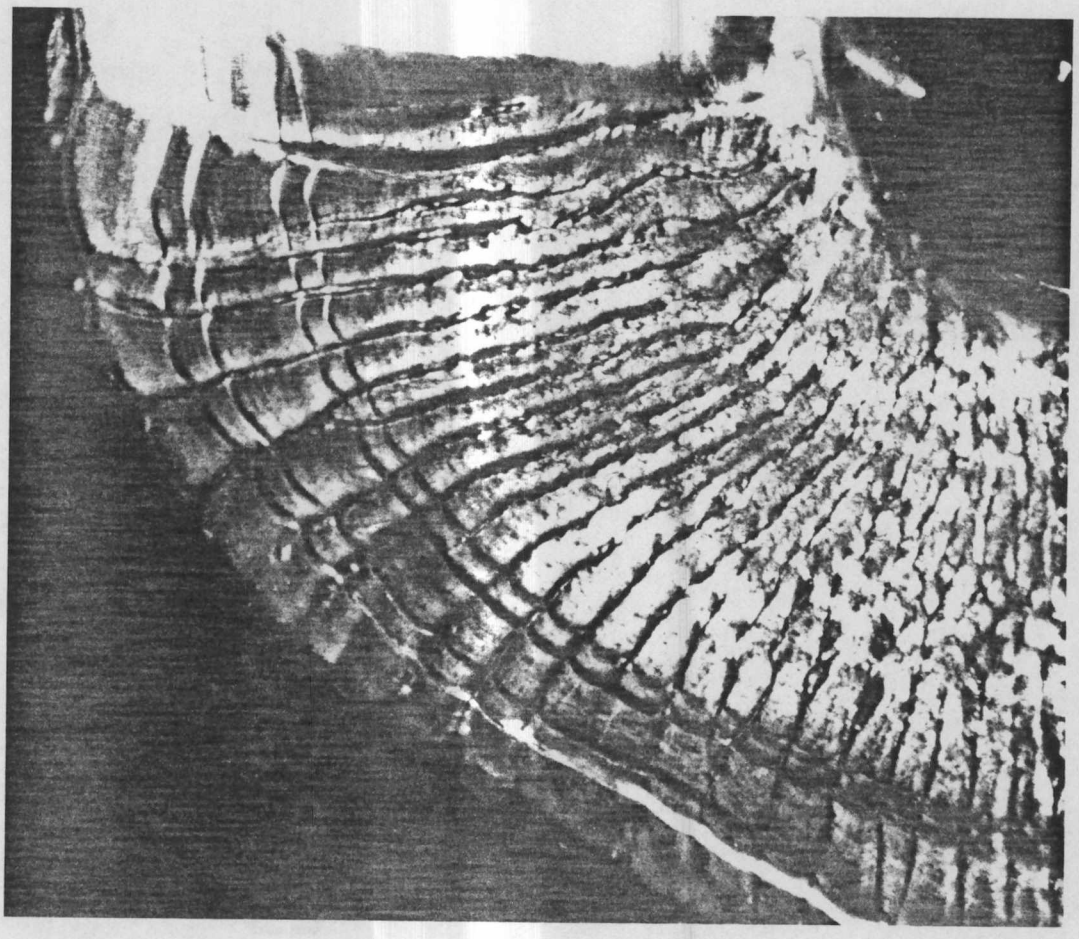


Figure 45. Clarias spine cross-section showing consistent spring-early summer arrest line over several years. (Note closely spaced pairs of arrest lines.)

relatively small it cannot be determined if this character is limitted to female fish or is present in both sexes.

Statistical Analysis

Figure 46 shows the growth ratio of the 84 modern Clarias specimens plotted against the date of their capture. The plotted values verify an expected problem; nonconstancy of the error variance. This phenomena is not uncommon when dealing with time-related problems (Neter and Wasserman 1974), but it must be corrected since regression models assume constancy of the error variance.

Data transformations, however, can be used to help stabilize a nonconstant error variance. Taylor's power law (Taylor 1961) was applied to rectify the problem. Taylor's law (1961) states that the variance of a population is proportional to a fractional power of the mean. The appropriate transformation is to raise each original observation, in this case the growth ratio, to a fractional power of 1-b/2, where b is a slope coefficient. The value for b was derived as follows: first, the mean and variance of each discrete sample in the data set was obtained. Clarias spines were grouped into 12 discrete samples according to the month in which they were captured. The 12 mean and variance terms were then transformed to their common log values. The resulting terms were regressed (log variance by log mean), and a least square line fit to the data. The slope coefficient of this regression was then substituted for b in the equation above. In this case the slope coefficient was 1.1532. When substituted for b in the equation, the resulting value is 0.423.

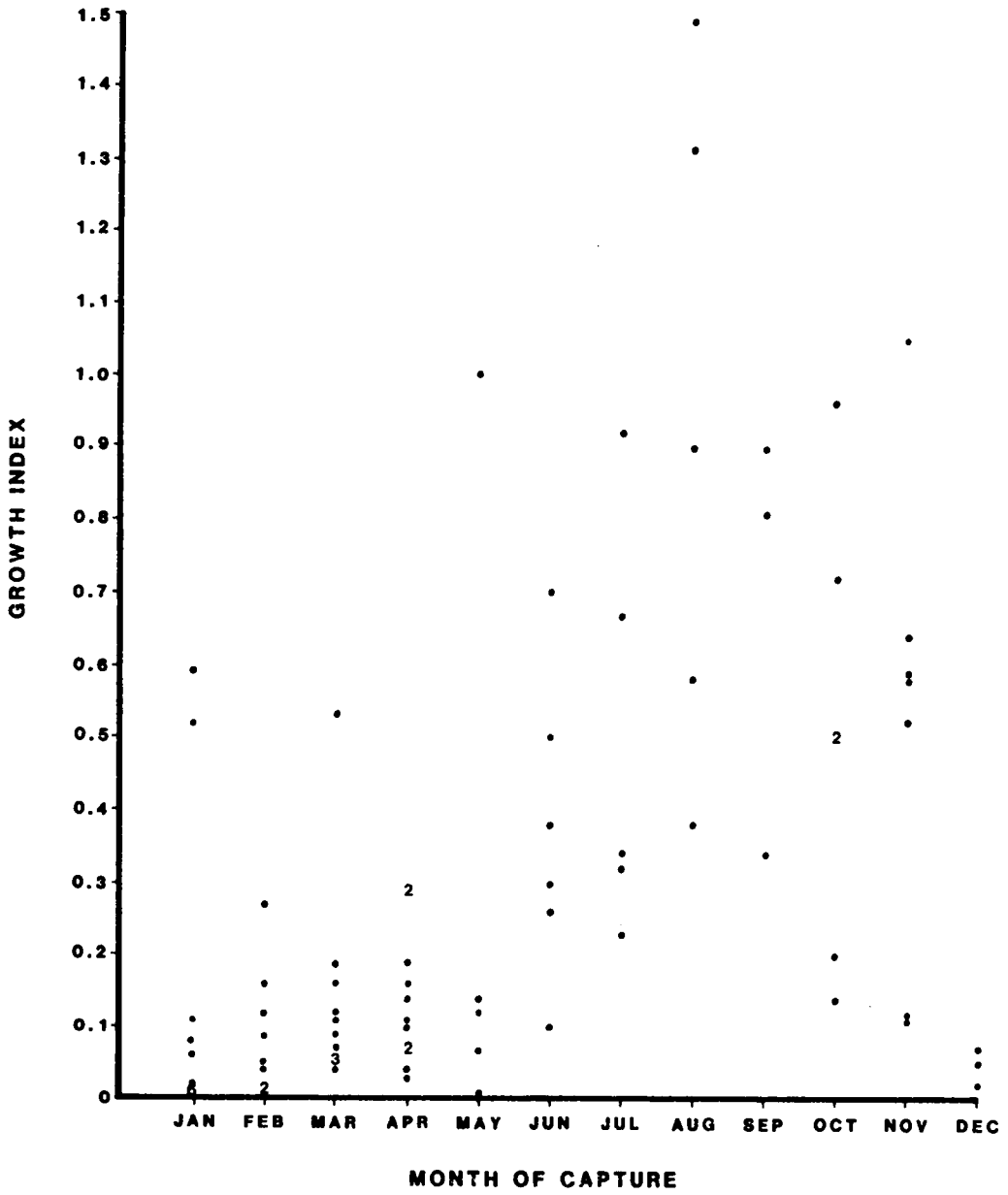


Figure 46. Plot of pectoral spine growth index by month of capture for 84 modern Clarias.

This value is the fractional power to which each original growth ratio was raised. An analysis of the residual values plotted in Figure 47 suggest that the error variance has been effectively stabilized.

Predicting the season of death for Clarias through an analysis of pectoral spines recovered from Fayum A and B cultural assemblages can be accomplished via a linear regression model. However, using such a model would be rather cumbersome and inconvenient. Growth, because it is measured with error, would have to be treated as the Y variable. Alternative procedures would produce invalid results. Consequently, a known value for Y, in this case the growth ratio computed from archaeological specimens, would have to be associated with an unknown X value, the date of death. This would require a cumbersome table depicting all possible Y values for each possible X value. Consequently, analysis of variance provided a more parsimonious way of demonstrating differences in growth across time and aided in the eventual prediction of the season of death of the unknown archaeological samples.

Monks (1981) advocates the use of calendrical dates for establishing the time of year or season of site occupation. He feels this form of measurement superior to less precise methods of seasonal dating such as stating a "spring" or "summer" occupation. By claiming the superiority or at least the desirability of calendrical dating, Monks has failed to consider the inherent variability of the phenomena being measured. A calendrical date for an occupation of July 12 is no more accurate than stating a "summer" occupation if the natural variability, that is the standard deviation, for the measured entity encompasses the period from

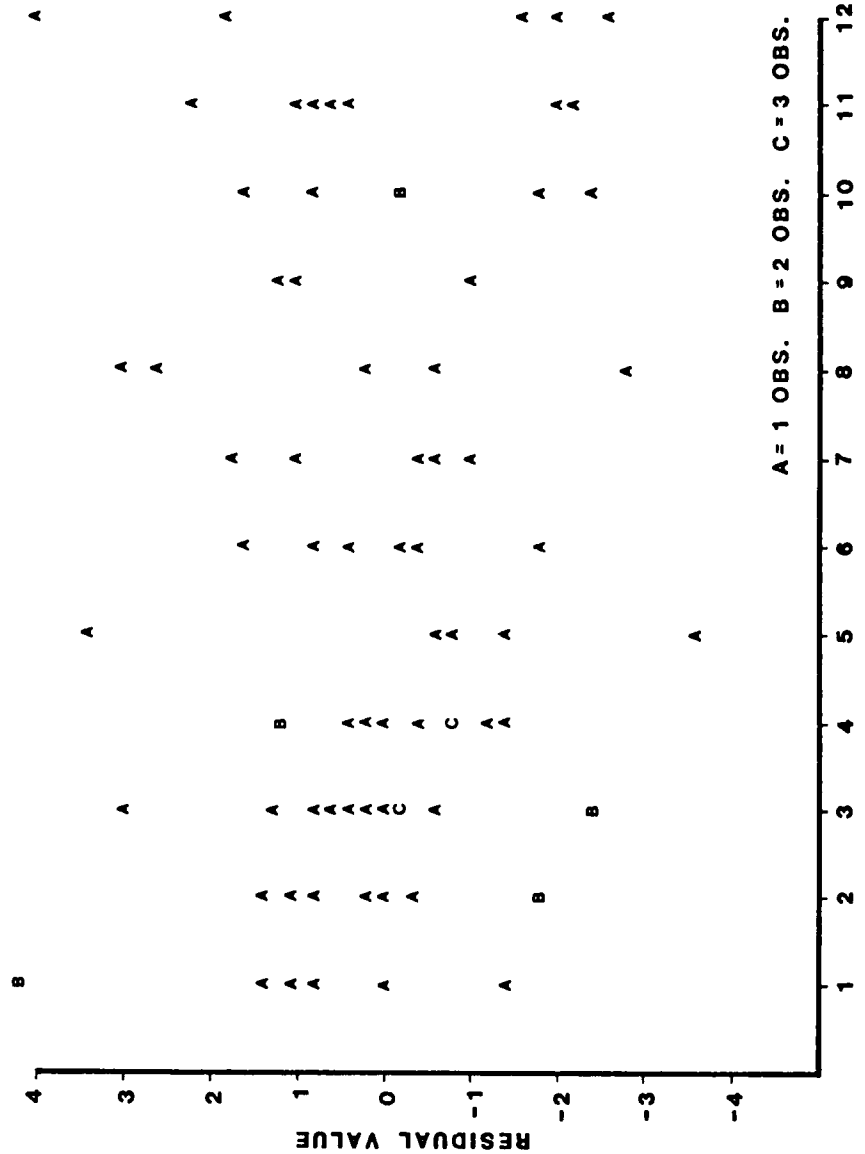


Figure 47. Plot of residual values by month of capture. A = 1, B = 2, C = 3.

June 12 to August 12. Additionally, calendrical dates are constructions of convenience we have imposed on time. It is very unlikely that prehistoric Fayum inhabitants marked the passage of time by using our calendrical dating system. Consequently, it would seem appropriate to divide the year into units which would have meaning in terms of naturally occurring phenomena such as seasonal temperature cycles. For example, while the day marking the onset of increasingly warm temperatures may fluctuate from year to year, the period or cycle would still exist and return in the same relative position compared to other temperature regimes each year. Furthermore, seasonal temperature cycles appear to be closely correlated with fish growth as well as a probable marker for the onset of certain human subsistence practices.

Egypt exhibits four marked temperature regimes (cf. El Danasori 1957; Osborn and Helmy 1980): a period of steady cool temperatures lasting from December through February, a period of increasing temperatures extending from March through May, a period of steady warm temperatures from June to August, and a return to cooler weather from September through November.

Data from the modern Clarias samples were grouped according to their date of capture into the appropriate temperature regime. The variance for each of the four groups was computed and the Bartlett Test for the equality of population variances was applied (Neter and Wasserman 1974). The computed figure with three degrees of freedom at the 90% confidence interval must exceed a value of 6.25 for the respective group variances to be considered significantly different. A value of 1.76 was

calculated, substantiating the earlier claim that, based on residual analysis, the nonconstant error had indeed been remedied.

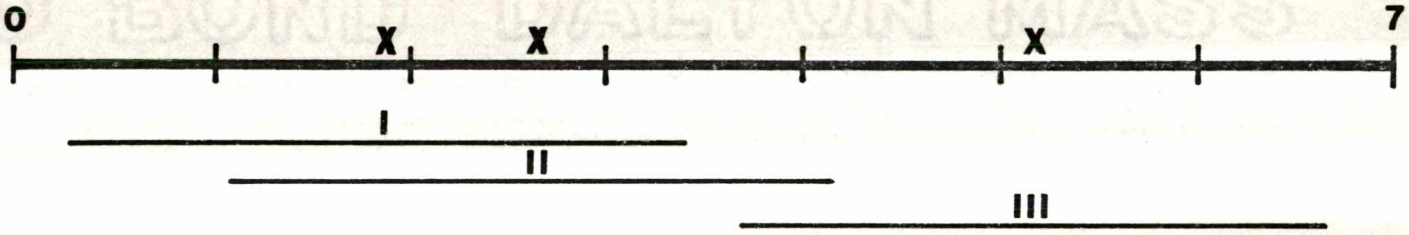
An analysis of variance of the four groups representing Egypt's four temperature regimes was then conducted. In addition to this, four a priori tests were defined on the basis of the working model that increased seasonal temperatures should reflect increased growth. The mean for Group I (Dec.-Feb.) was predicted to be significantly less than the mean of Group II (Mar.-May), Group II less than Group III (June-Aug.) and Group III less than Group IV (Sept.- Nov.).

Results from the analysis of variance (Table 7) showed measurable nonrandom effects existed between groups beyond the .0001 level of confidence. Bonferroni a priori tests at the 10% level of confidence showed that the mean for Group I was significantly less than the mean of Group II, Group II was less than Group III, but Groups III and IV were shown to be not significantly different from each other. A nonsignificant value for the final test did not come as a surprise since Clarias would most likely attain the majority of growth before the onset of decreasing temperatures. Growth added during the period of decreasing temperature (Fall) would be minimal when compared to the sum of the previous seasons, resulting in a nonsignificant statistical test.

Using the information gained from the statistical tests applied above, a comparative figure was constructed using the mean from each significant group plus or minus one standard deviation (Figure 48). The nonsignificant groups (III and IV) were combined to form one group. The mean square error taken from the analysis of variance was used as the

Table 7. Analysis of variance (SAS).

Source	DF	Sum of Squares	Mean Square	F Value	PR > F
Model	3	176.99806965	58.99935655	25.0	.0001
Error	80	188.80543149	2.36006789		
Total	83	365.80350115			



Group I. Dec. - Feb.
Group II. Mar. - May
Group III. Jun. - Nov.

Group I. $\bar{x}_I = 1.865$
Group II. $\bar{x}_{II} = 2.645$
Group III. $\bar{x}_{III} = 5.107$

Figure 48. Seasonality comparative chart.

"best estimate" for the variance of the natural population. The square root of this figure (1.54) supplied the value for the standard deviation. The growth ratio of the archaeological spines raised to the 0.423 power could then be compared to the results shown in Figure 48 and the season of death directly read from the figure.

Before work on the archaeological samples began, a series of tests were applied to the model to insure its reliability and consequently strengthen its validity as a predictive tool. The spines which were pulled from the sample before analysis began and spines collected from different areas by different individuals were used for the test. Figure 49 presents the results of the test. Spines collected from the same general area during the same year and spines collected during the following year (1985) were all correctly assigned to their appropriate season of death. Spines collected from El Minya and Luxor, located south of Cairo, also showed favorable results within the statistical limits (66%) of the model. It is felt, however, that further testing is needed before the model constructed from Cairo fish can be determined as valid for predicting samples taken from regions as far south as Luxor. Differences in temperatures from season to season in Luxor are not as extreme as in Cairo; consequently, fish growth may be more dependent on factors other than temperature. Fish growth in these southerly areas may also possess a greater population variance than fish taken from more northerly latitudes. This would result in inaccurate assessments of seasonality based on the current model. Nevertheless, test results suggest that the model is a valid and reliable predictor, within the

Collection group:	A	B	C	D		E
Sample area:	Cairo	Cairo	Cairo	Minya		Luxor
Collection dates:	4-17-84	8-29-83	11-15-83	4-17-84	4-17-84	4-4-84
	4-17-84	2-11-84	11-15-83	4-17-84	6-17-84	4-4-84
	4-8-84	6-26-84	11-15-83	4-17-84		4-23-84
$X^{.423}$	2.2776	5.571	5.03	3.55	2.27	3.63
	2.2776	0.00	5.23	3.47	2.65	3.84
	3.0536	4.2152	7.81	2.53		4.23

*circled letter indicates incorrect assessment of season of death

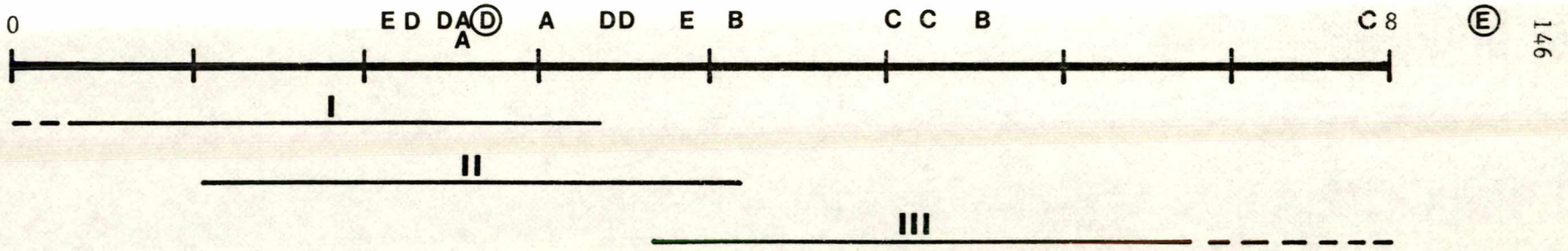


Figure 49. Reliability test for constructed seasonality model.

prescribed limits, for estimating the season of death for Clarias in the Fayum/Cairo region.

Results

Spines recovered from Fayum A (Figure 50) and B (Figure 51) sites, when compared against the model, showed a relatively large cluster of values in the upper regions of Group II and/or the lower regions of Group III. This, given the variation in measurements inherent in the population, would correspond to a period of temperatures similar to those of modern Egypt's late spring or early summer. Both Fayum A and B tests show several outlying values in the upper reaches of the Group III/IV temperature regime. A statistical test on the combined Fayum data based on standardized scores for normally distributed populations (Hays 1981) showed that, given a population standard deviation of 1.54, there was less than a 0.21% chance that the outliers came from the same collection population. This suggests that Clarias was collected at two different periods of the year; these periods corresponding to the temperature regimes indicative of modern Egypt's late spring-early summer and summer/fall.

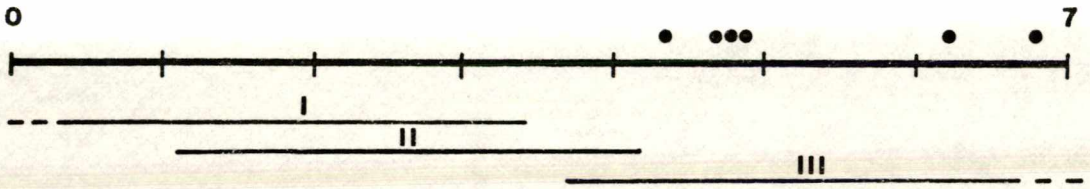
Discussion

Faunal evidence presented in Chapter 3 supported by Kendall's Coefficient of Concordance, suggest that the five Fayum sites incorporated in this study served a similar function. Evidence presented in this chapter suggests further similarites in regard to seasonal procurement

SEASONALITY

COMPARATIVE CHART

FAYUM A



GROUP I Dec. - Feb.

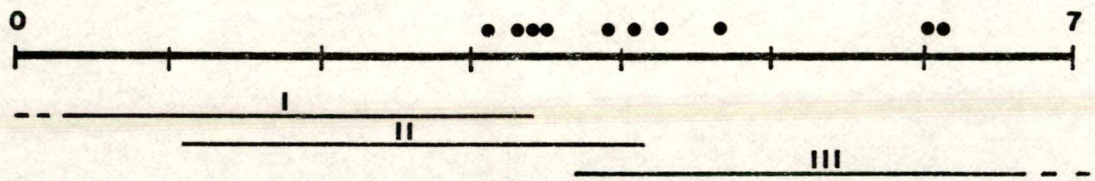
GROUP II Mar. - May

GROUP III Jun. - Nov.

Figure 50. Seasonal assessment of Fayum A spines.

SEASONALITY
COMPARATIVE CHART

FAYUM B



GROUP I Dec. - Feb.
GROUP II Mar. - May
GROUP III Jun. - Nov.

Figure 51. Seasonal assessment of Fayum B spines.

strategies: both Fayum A and B peoples collected Clarias during a temperature regime similar to modern Egypt's late spring-early summer and again in the summer/fall. Fishing for this catfish has, up to this time, been considered a fall occupation, coinciding with the annual period of inundation. This evidence, however, appears to contradict at least in part this assumption. Reasons for obtaining Clarias during the late spring-early summer are purely speculative; however, some evidence does exist that spawning may take place or could have taken place earlier than previously believed (see Chapter 3). Clarias would be densely aggregated during the spawning period and this would facilitate their capture. Additionally, this period coincides with the onset of warmer weather that would bring about an increase in planktonic organisms which are used as food by C. lazera. It is also the spawning season for several Clarias food species such as Tilapia (Chapter 3). An increase in the density of potential food species in shallow water areas could induce Clarias to congregate there in large numbers, facilitating their capture by Fayum inhabitants. Clarias living in shallow water areas are known to hunt in packs "rounding up" or pushing their prey into an ever decreasing area and thus limitting their ability to escape. Clarias open and snap their mouths shut, creating noise to excite their prey. When available space is sufficiently reduced, the prey species are consumed (Bruton 1979). One final consideration regarding the season that Fayum fishing activities may have occurred, has been proposed by Wendorf and Schild (1976). They believe that fishing took place during the

seasonaly low stages of the lake. This interpretation would agree with the estimated late-spring early summer collection date.

Based on the evidence from modern avian migration patterns, recovered avian remains were all identified as species that occur in the Fayum during the winter months. This period corresponds to a cycle of consistent reduced temperature. Although the seasonal migration of the prehistoric Fayum's avian taxa may not have commenced on the same calendrical dates as their modern day counterparts and the length of time these taxa occupied the area might also have differed, it is still highly probable that their presence in the region reflect seasonally reduced temperatures in more northerly latitutes. Consequently, peoples occupying both Fayum A and B sites must have been in the Fayum area during the temperture cycles indicative of modern Egypt's late spring-early summer and summer/fall. They also must have been in the area at sometime during the period of reduced temperatures, Egypt's winter, in order to take advantage of the large diverse populations of migratory birds. The evidence fails to substantiate the existence of any detectable differences between seasonal procurement strategies employed by the inhabitants of Fayum A and B sites. That is to say, no evidence exists in support of hypotheses regarding Fayum A and B cultural assemblages as representative of two distinctly different procurement and settlement strategies.

CHAPTER 5

ENVIRONMENTAL RECONSTRUCTION OF BIRKET QARUN AND THE FAYUM DEPRESSION

Birket Qarun has undergone drastic changes in size and chemistry since the time of the Fayum A and B occupations. The level of salinity in the lake today is about equal to that of the Mediterranean Sea (36-38%) and the lake becomes increasingly more saline (.5-.8 gm/l) each year (Boraey 1980). Freshwater fishes such as Labeo, Barbus, Bagrus, Lates, and Clarias have all disappeared as a result of the increased salinity (Boraey 1980; personal observation). Additionally, Boraey (1980) has noted a marked increase in the level of sulfer compounds in the lake.

Present day Birket Qarun is 45 km long (east to west) and 5.7 km wide (north to south). Maximum lake depth is 8 m, with lake volume estimated to be 960 X 10^6 m^3 (Boraey 1980). At least 40% of Birket Qarun's shoreline has been converted to agriculture. The remaining 60%, lying mainly along the lakes's northern boundary, generally lacks vegetative cover; water and desert meet as a narrow strip of sandy/rocky shoreline. Prehistorically and even as recently as the Old Kingdom (2700-2215 B.C.) the lake stood as high as 20 m above sea level and was three times its present volume (Faouzi 1936).

The prevailing hyperarid conditions characterizing Egypt and the Fayum Depression today were interrupted during the Holocene by several

pluvial periods. These periods are characterized by the deposition of local sands and gravels in the form of wadi terraces, wadi fans at the edge of the Nile Valley, and wadi materials redistributed far downstream along the bed of the Nile (Butzer and Hansen 1968). In comparison, at present the tributary wadis of Egypt and Nubia contribute practically no sediments to the Nile flood plain. Infrequent rainstorms and local wadi floods do little more than redeposit wadi-sediment materials.

Holocene deposits associated with Egyptian wadis suggest a moister climate with more frequent rains and of a greater intensity than occur today (Hassan 1985; Butzer and Hansen 1968). This is argued from several lines of evidence. First, greater stream competence would be required to transport a bed load which was much coarser than the one moved today. Similarly, the preserved deposits in small to intermediate-sized wadis commonly indicate a wadi bed several times broader than the wadi floors of today. This can best be explained by greater discharge and a greater bed load. In particular cases, upslope areas from which alluvial materials were derived were traced, providing evidence for exceptionally significant overland flow and upland denudation (Butzer and Hansen 1968).

Butzer (1975) believes that wadi discharge was interrupted during three major dry intervals centered approximately 9500 BC, 5500 BC, and 4500 BC. The two latter dates correspond to the cultural hiatus found between Fayum A and B occupational periods, and to a period when Birket Qarun was at a greatly reduced level or perhaps totally absent (cf. Wendorf and Schild 1976). Research conducted by Bakkar and Maley (1979),

Flohn and Nicholson (1980), Dumont (1982), and Hassan (1985) all provide similar evidence for a Holocene pluvial period interrupted by an intense phase of aridity ca. 5000-4000 BC.

Environmental conditions at Birket Qarun are, however, not solely dependent upon local precipitation evapo-transpiration levels. The Egyptian Nile, which contributed water to the Fayum Depression, derives its waters almost exclusively from the rains which fall over the equatorial plateau of Central Africa and the Ethiopian Plateau (Said 1975). Unfortunately, the evidence concerning Nile flood levels during Fayum A and B times, is rather limited in geographical scope. The main evidence for changes in flood levels comes from Wendorf and Schild's (1976) study of Birket Qarun. High Nile floods and consequently high lake levels are considered to have prevailed during Fayum A and B times but a period of low Nile flooding resulting in low lake levels or a disappearance of the lake occurred around 5000-4000 BC. This corresponds with the period of increased aridity reported by Butzer (1975) and others and with the limitted information available on Nile levels from Nubia (Table 8).

The relative importance of local precipitation to Nile flood levels is still unknown. However, the magnitude of Nile floods appear not to be governed by local precipitation or any predictable pattern of periodicity (Said 1975). Nevertheless, remains of the fish Tetraodon fahaka and Lates niloticus, both third order colonizers, suggest that Birket Qarun offered a stable lacustrine environment for at least the period of time corresponding to the Fayum A and B occupations. Both Fayum A and B

Table 8. Evidence from Nubia of high Nile floods (Wendorf and Schild 1976).

Level of Nile Above Modern Flood Plane	Geological Evidence	Dates (BC)
+5m	Aggrading floodplain silts at Dibeira West 50	3460 ± 150
Low Nile ?	Hiatus	ca. 4000-5000
+16 m	Catfish Cave, Nubia	5110 ± 120
+6 m	Floodplain at Dibeira West 53	5960 ± 120
+9 m	Channel and levee at Dibeira West 51	5750 ± 20
+13 m	Nile bar at Dibeira West 1	5750 ± 120
+13	Oyster bed at Gebel Halfa	7410 ± 180

faunal assemblages share the same compliment of first to third order colonizers.

Evidence gathered by Wendorf and Schild (1976) from the northern section of the Fayum depression suggest that lake levels fluctuated several times during the Holocene. Furthermore, Hassan (1985) believes that without an influx of water from the Nile, Birket Qarun could have disappeared in as little as 40 to 100 years. Third order colonizers such as Tetraodon and Lates would not normally be expected to flourish in an environment characterized by such repeated drastic changes in water level. Consequently, recolonization of the lake by first, second, and third order fish would have had to occur in a relatively short period of time to accommodate the recovery of Tetraodon and Lates from both Fayum A and B occupations.

Although rates of colonization measured across time undoubtedly differ from area to area and across different suites of taxa, a period of less than 1000 years appears, intuitively at least, to be very short for a complete replacement of all species (cf. Bruton 1979). Colonization could be facilitated, however, by direct access to the Nile via the Hawara channel. Hassan (1985) believes, based on a study of Fayum sediments, that Nile floods and not increased precipitation account for the high lake levels. Additionaly, Paul Buck (personal communication 1985) and Wendorf and Schild (1976) have interpreted sedimentological evidence gathered from several Fayum sites as characteristic of a cyclic deposition of silts. A seasonal or even a periodic connection of some duration between the Nile and Birket Qarun during Fayum A and B times could

account for the deposits noted by Buck, Wendorf, and Schild as well as for a rapid recolonization of the lake by fish. Such a connection would also account for the distinctive Nilotic character of Birket Qarun's ichthyofauna, in particular Tetraodon which today is restricted with other third order colonizers to the Nile.

Further evidence deduced from Fayum faunal remains, gathered from Upper-Paleolithic and Neolithic sites, supports findings indicative of more mesic conditions. The preferred habitats of identified avian taxa imply that areas surrounding prehistoric Birket Qarun possessed emergent shallow water vegetation. Recovered species such as Gallinula chloronus (moorhen), Porphyrio cf. madigascariensis (green-backed gallinule), and Ixobrychus minutus (little bittern) prefer to inhabit areas with thick reed beds (Meinertzhagen 1930; Meininger and Mullie' 1981). Meinertzhagen (1930) and Boulenger (1907) make reference to stands of thick reed beds existing in the Fayum in the earlier parts of this century.

The local ichthyofauna also appears to reflect a more mesic habitat, particularly the evidence pertaining to shallow water areas. Clarias spp., which predominates in the recovered faunal assemblages of both Fayum A and B sites, lives, feeds, and breeds in shallow water environments (Bruton 1979; Boulenger 1907; Sandon and Tayib 1953; Pekkola 1919). Species characteristic of well oxygenated deep water habitats such as Lates niloticus also appear to have thrived during Fayum A and B times. Some of the remains identified as Lates where from fish of tremendous proportions (ca. 71 m in length), reflecting the presence of favorable conditions for achieving maximum growth.

Boulenger (1907) states that at the turn of the century Birket Qarun was noted for its large Nile Perch (L. niloticus). Faunal evidence from identified mammalian taxa further supports the idea of a lush oasis or Nilotic type environment. Gazella and Bos remains indicate that the area supported a succulent vegetation. Fossil remains of trees (personal observation) near former shorelines also may indicate more mesic conditions.

The presence of numerous taxa, all suggesting similar and complementary environmental conditions, provide a strong argument for the Birket Qarun area as once having possessed a significant shallow water resource area. Geomorphological data compiled by Wendorf and Schild (1976), Kozlowski (1983), and Hassan (1985) substantiate this by the documentation of former beach ridges indicative of a lake much greater in area and by the deposition of sediments characteristic of shallow water regimes far beyond the limits of todays lake. An increase in lake area would accommodate a larger shallow water environment providing the potential to support increased populations of taxa adapted to this type of habitat, taxa indicative of the fauna recovered Fayum A and B occupations.

Paleotemperatures

Evidence documenting changes in the magnitude of Nile floods and evidence of increased precipitation through the study of wadi activities have contributed substantial data on the Holocene environments of Egypt. However, investigations concerning changes in temperature, an important

factor contributing to the effectiveness of increased precipitation (cf. Thornthwaite 1948), are conspicuously lacking.

Towards this goal an analysis of the phosphate bound O-18 of fish bone apatite was conducted for the purpose of estimating relative changes in lake temperatures during Fayum A and B times. Isotope analysis was conducted by Dr. Y. Kolodny at the Institute of Earth Sciences, The Hebrew University of Jerusalem. Although critical analysis of the technical procedures employed (Figure 52) are beyond the expertise of this author, a general description of the underlying principles and some critical comments regarding the faunistic components of the study are presented below.

The possibility of using a phosphate oxygen isotope thermometer was first proposed in 1951 (Urey et al. 1951). The rationale supporting the initial research was based on the principle that by using a combination of phosphate and carbonate, problems involving the O-18 isotopic variation inherent in water could be eliminated (Kolodny et al. 1983; Urey et al. 1951). That is to say, PO4-3 oxygen and carbonate from a living organism could yield estimates of temperature without knowledge of the isotopic composition of the fluid medium in which the animal lived. Measurements of O-18 from an aquatic organism would be equal to the average O-18 composition of the water in which the animal lived.

Measuring phosphate oxygen became possible after Tudge (1960) developed an analytical method and proved that PO4-3 does not exchange its oxygen with water during inorganic reactions. Reactions indicative of the laboratory procedures used to isolate and count the isotopes.

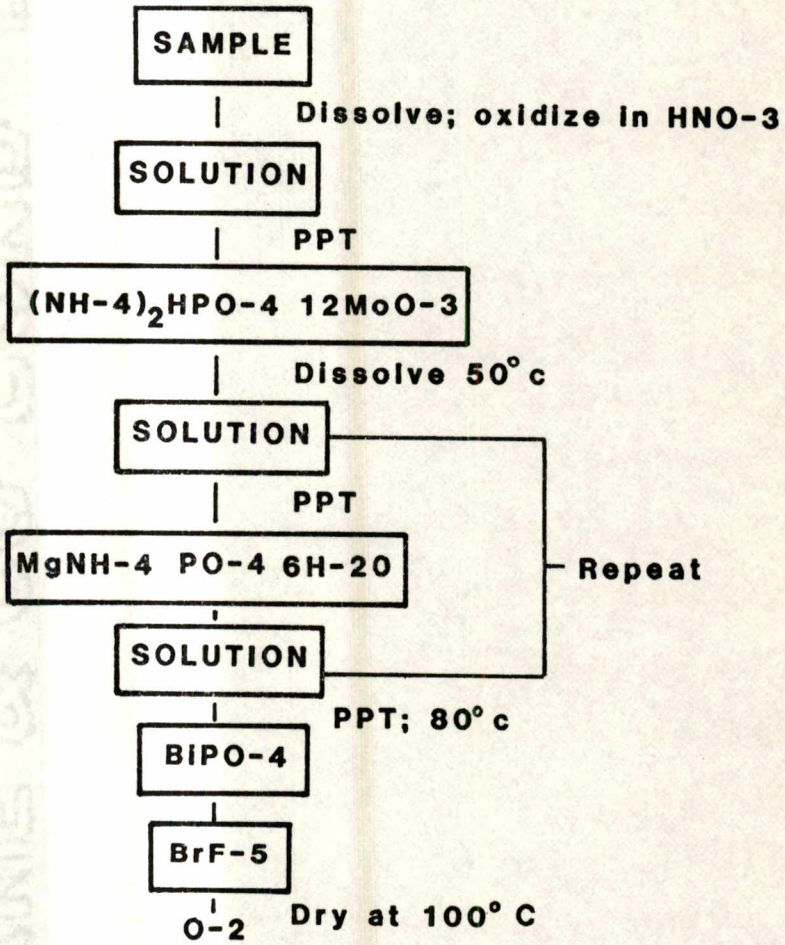


Figure 52. Isotope analysis laboratory procedure.

Following Tudge, Longinelli and his coworkers published a series of articles dealing with the oxygen isotope compositions of phosphate in carbonate shells, fish bones, and marine phosphorites (Longinelli 1965, 1966; Longinelli and Sordi 1966; Longinelli and Nuti 1968a, 1968b, 1973a, 1973b; Longinelli et al. 1976). These initial experiments were not without error (cf. Longinelli and Nuti 1973a); however, once the problems were resolved a least squares equation was developed (Longinelli and Nuti 1973a) expressing the linear relationship between δO-18b and temperature: $t°c = 111.4-4.3\ (\delta b-\delta w)$, where t is the average growth temperature and δb and δw are the δO-18 values of the animal phosphate obtained from bone and water respectively (Kolodny et al. 1983). The lower case delta (δ) denotes the difference, expressed as a percentage, between O-18/O-16 and a selected standard.

The method basically exploits the temperature related uptake of the O-18 isotope in aquatic ectothermic organisms. As temperatures rise the δO-18 values decrease. It should be noted, however, that there is no precise definition of the temperature at which a fish lives or for that matter builds its skeleton. Therefore, the temperature estimate from the δO-18b equation should be regarded as an "effective temperature" reflecting some integrated average life temperature for the fish.

In enzyme catalyzed reactions, such as the reactions occurring in the formation of teeth and bones, the exchange of O-18 between water and PO4-3 is extremely rapid, requiring only minutes for total exchange (Tudge 1960; Dahms and Boyer 1973). Additionally, the isotopic exchange after the organisms death is so slow that it is considered negligible

even over geological time scales (Kolodny et al. 1983). Therefore, skeletal elements from organisms living in water possess an ideal geochemical temperature recorder.

Kolodny et al. (1983) tested the δO-18w--δO-18b relationship and the equation developed by Longinelli and Nuti (1973a). By comparing estimated temperatures derived from the δO-18b of fish bones to known water temperatures and δO-18w values, they were able to verify the utility of the method. The results of the isotopic analysis are summarized in Table 9. In almost all cases the estimated temperature correctly reflected the actual average water temperature. Also included in the table are the results of two complimentary experiments set up to test the validity of the model's assumptions. One experiment was conducted at a lake possessing different water temperatures at different depths. The other experiment was to determine the influence of diet on derived isotope values.

Thermal Stratification Test

Lake Baikal in eastern Siberia provided a check for the internal consistency of the employed method. Four fish species that occupy different depths were tested and resulting values compared to the measured lake temperatures at corresponding depths. Most estimated temperatures fell within 1.3°c of the actual measured values.

Effects of Diet

In addition to the exchange of isotopes with water, another possible contributor of O-18 might be the phosphates found in the food eaten

Table 9. Test results of isotope analysis (Kolodony et al. 1983).

	Species	Locality	δ0-18w	δ0-18b	Year Range t°C	Estimated t°C
1.	Nirogrex terraesanctae	L. Kinnereth	-2.1	19.4	13-30	18.5
2.	Mugil cephalus	L. Kinnereth	-2.1	19.6	13-30	18.5
3.	Sarothrodon galilaeos	L. Kinnereth	-2.1	19.4	13-30	22.8
4.	Epinephelus sp.	Mediterranean	1.5	22.3	18-28	22.0
5.	Scaruss sp.	Gulf of Elat	1.9	23.3	21-26	22.0
6.	Scaruss sp.	Gulf of Elat	1.9	22.7	21-26	22.0
7.	Siganus luriadus	Gulf of Elat	1.9	22.6	21-26	23.2
8.	Variola louti	Gulf of Elat	1.9	22.2	21-26	23.3
9.	Epinephelus fasciatus	Gulf of Elat	1.9	23.2	21-16	23.2
10.	Tetradontid	Gulf of Elat	1.9	22.2	21-26	23.2
11.	Sparus aurata	Bardawil lagoon	1-7.5	25.2	11-30	25.4
12.	Sparus aurata	Bardawil lagoon	1-7.5	23.6	11-30	25.4
13.	Sparus aurata	Bardawil lagoon	1-7.5	24.0	11-30	25.4
14.	Sparus aurata	Bardawil lagoon	1-7.5	25.0	11-30	25.4
15.	Salvelinus namycush	L. Inari	-13.3	11.1	4.2	6.4
S-1	Perca sp.	L. Baikal	-15.9	6.0	1-18	16.8
S-2	Coregorius sp.	L. Baikal	-15.9	7.3	4-9	11.2
S-3	Cottus sp.	L. Baikal	-15.9	9.0	3-8	3.9
S-4	Battrochocottus sp.	L. Baikal	-15.9	9.2	3-4	3.0
P-1	Salmo sp.	Karaun	-8.0	14.9	14-?	13.0
P-2	Salmo gairdneri	Dan Fish Ponds	-7.5	15.4	13.5-16.5	11-15

by the tested fish. The Dan Fish Farm (Israel) offered an opportunity to check this possibility. The δO-18 value of the pond water was -7.5 ppm (δO-18w) and the temperature was 15 ± 1.5°c. The expected δO-18b was 14.4-15 ppm. Trout which are raised at the Dan Farm were fed fish meal from ground marine fish. The δO-18 value of the food phosphate was 23.8 ppm. In spite of the high phosphate level in the food the δO-18b value of the trout measured 15.4 ppm. Furthermore, the δO-18b composition of Dan trout is very close to that of Karaun trout farm (Israel) which live at a similar temperature and δO-18w but are fed fish meal with a markedly different δO-18 value. Consequently, the isotopic composition of oxygen in fish appears to reflect the aqueous environment and not the phosphate level of the food consumed (Kolodny et al. 1983).

The success in estimating water temperature from fish bone apatite opens the possibility for estimating paleotemperatures from fish remains recovered from Fayum A and B cultural assemblages. However, a value for δO-18w (water-phosphate) is necessary to carry out the computations for the temperature estimates. It is obvious since this value cannot be directly obtained from the waters of prehistoric Birket Qarun that it must some how be estimated.

Kolodny et al. (1983) and Luz et al. (1984) have attempted to estimate δO-18w values through analysis of δO-18b obtained from the bones of warm blooded animals recovered in context with fish bones.

Endothermic animals maintain a relatively stable body temperature, therefore leaving variability in δO-18b values as a response to changes in the isotopic composition of the mammal's water source. Implicit in the use of mammals for estimating δO-18w from δO-18b is the assumption that the mammal being analyzed obtained its water from the same habitat as the fish.

In order to demonstrate the potential of this method, Kolodny et al. (1983) analyzed the remains of deer from modern, Neolithic, upper Paleolithic, and Upper Mousterian sites from the Jordan River area. All bones and teeth had a δO-18b of 21-22 ppm, suggesting that no major changes occurred in the δO-18w of the area during the late Pleistocene.

Unfortunately, the sources of body water in mammals, unlike fish, is quite diverse. This includes drinking water, water in food, and metabolically produced water. Because the values obtained through bone apatite analysis are "life time averages," the estimate for δO-18w obtained from mammals could represent a dubious figure when regarded as an estimate for a particular body of water. Equivalent values obtained by Kolodny et al. (1983) for deer, spanning from Mousterian to modern times, may be a case in point. The δO-18w values from the deer represent an average of all the water sources utilized by the animals during their lifetime. Because the computed estimate is an average it minimizes the ability to detect differences in δO-18w values of particular water sources over time. Additionally, the question arises as to what is actually being measured: changes in δO-18w of one water source across time or changes in water sources, or both.

Using Fayum mammals as an example, even if a difference in estimated values were to be detected it would be difficult to assess what water source was indeed changing. A gazelle, for instance, can eat succulent vegetation from one area, drink brackish water from another area, and then travel a considerable distance to Birket Qarun to take advantage of the resources found there. Also, the use of mammalian remains from different time periods serves to compound the problem. The mammals from different time periods used in analyses must be assumed to have obtained water from the same sources.

Table 10 presents the δO-18b values obtained from bones recovered from Fayum A and B assemblages. Theoretically, to be valid indicators of Lake Qarun's δO-18w content, bone samples from Gazella and Bos representing the same time period and recovered from the same cultural assemblage should produce similar δO-18b values. This, however, was not the case. Values of δO-18b for Bos and Gazella recovered from the same assemblage are markedly different. It is likely that these differences reflect the different habitat preferences between these two groups. That is, different habitat utilization would result in different sources of water entering into the animal's system, resulting in nonequivalent δO-18b values. If the δO-18b values are indeed a reflection of the habitat preferences of the tested genera, then δO-18b values obtained from Bos remains regardless of site type or provenience should be more similar to one another than to values obtained from gazelle. Results presented in Table 10 do not refute this assumption. Consequently, at this stage of development, the validity of δO-18w estimates based on

Table 10. Isotope analysis of Fayum materials.

Site	Taxa			
	Clarias	Synodontis	Gazella	Bos
Fayum A (site 1)	18.6	-	26.1	19.3
Fayum B (site 2)	21.2	19.4	23.6	-
Fayum A (site 5)	21.0	17.9	-	21.9

Values are presented in δ per militer.

mammal bone apatite (δO-18b) can not be considered as valid for estimating paleo-lake temperatures.

If, however, the scale of measurement were reduced from an interval scale based on temperatures to an ordinal scale based only on the δO-18b values derived from fish apatite, the δO-18b values could be used to determine if any significant changes had occurred in Birket Qarun's water temperature between Fayum A and B times. Looking again at Table 9, similar temperature estimates are the result of similar δO-18b values, given that no significant change in the δO-18w content of water has occurred. Because Fayum A and B lakes were both derived from the same source, the Nile, no significant changes in the δO-18w content of the water would be expected to have occurred. This would leave changes in temperature as the best explanation for changes in δO-18b values from fish recoverd from prehistoric Birket Qarun.

The results of the isotope (Table 10) show, for Site 2 (Fayum B) and Site 5 (Fayum A), the difference between the δO-18 values of Clarias was 0.2 (21.2-21.0) and for Synodontis 1.5 (19.4-17.4). Values obtained by Kolodney et al. 1983 (Table 9) suggest that differences as great as 1.6 (e.g., Sparus aurata from Bardwell Lagoon) still provided the same temperature estimate. If no significant changes occurred in the δO-18w content of Nile River water, these values would indicate that relatively similar temperature conditions prevailed during Fayum A and B times. This interpretation agrees with relative estimates of lake temperatures based on the analysis of diatomites recovered from the Fayum Depression

(Aleem 1958; Boraey 1980). (Results from Site 1 were not considered because a value for Synodontis could not be obtained.)

Summary

Geomorphological evidence and evidence from identified faunal remains suggest that the Fayum Depression and the Western Desert experienced a pluvial phase during the Fayum A and B occupations. During this pluvial period rainfall was more frequent and of a greater intensitiy than occurs today. Nile floods were greater in magnitude, contributing more water to Birket Qarun and thus increasing its size. Faunal remains recovered from Upper Paleolithic and Neolithic sites suggest that the Fayum area supported a more mesic environment than today, one characterized by emergent shallow water vegetation and greater expanses of shallow water areas. A period of aridity lasting about 1000 years (ca. 5000-4000 BC) separated the two cultural periods. This phase of aridity also coincides with a decrease in Nile flood levels and a subsequent reduction of Birket Qarun's water level. With the return to more mesic conditions, the Fayum area was again rich in resources. The presence of Tetraodon and Lates, recovered in substantial numbers from both Fayum A and B sites, suggests that the conection between the lake and the Nile was either of a seasonal nature or lasted for a sufficient amount of time to allow for complete recolonization of the lake's ichthyofauna. The investigation of relative changes in temperatures by isotopic analysis during Fayum A and B times and the study of diatomites (Aleem 1958)

suggest similar temperatures prevailed during the terminal paleolithic and early Neolithic of the Fayum Depression.

CHAPTER 6

SYNTHESIS AND CONCLUSIONS

In Chapter 1 it was stated that the primary goal of this research endeavor was to shed light on the perceived differences in the cultural manifestations known as Fayum A and Fayum B. Differences in cultural assemblages attributed to different cultural affinities were contrasted against changing environmental parameters which it is believed directly influenced resource productivity in the Fayum.

In order to demonstrate a correlation between cultural and environmental change, a model was constructed based on the reliance of Fayum inhabitants on Birket Qarun's shallow water resource areas. It was suggested that a significant decrease in the productivity of this resource area, brought about by changing environmental conditions, would have required an adaptive response by the area's human inhabitants. These responses as outlined in Chapter 1 could have been in the form of a change in population aggregation including abandonment of the area, a change in resource utilization, or a technological change. The different options are not necessarily mutually exclusive. When testing the applicability of the model, it was necessary to demonstrate the utilization of shallow water resources by both Fayum A and B and to correlate changing environmental conditions with changes in the cultural record.

Three sites, two Fayum A and one Fayum B, were chosen for study. In addition to this the fauna from two other sites (Sites 4 and 5) were incorporated into the analysis. Investigations of the recovered faunal

material were conducted at three levels: standard taxonomic identifications, the study of structural components within certain skeletal elements, and an isotopic analysis of fish bone apatite.

During the Fayum B occupation, the Fayum as well as Egypt in general experienced more intense rains than occur in the area today (Butzer and Hansen 1968). Nile flood levels appear to have also been much higher, providing prehistoric Birket Qarun with enough water to sustain a lake approximately 60 m above present day levels. Areas surrounding the lake possessed an emergent shallow water vegetation interspersed with thick reed beds. Also, there are indications, based on the presence of fossilized wood (personal observation), that trees once existed along or near the prehistoric shorelines. All evidence suggests that prehistoric Birket Qarun possessed a productive shallow water area providing Fayum B occupants with an abundance of aquatic and terrestrial fauna.

Site 2, identified as upper-paleolithic (Fayum B), provided the largest faunal assemblage ever collected from a Fayum cultural activity area. Identified remains from this site support the premise that Fayum B did in fact possess a diverse resource base. Fayum B peoples utilized a variety of large terrestrial mammals including Bos, Gazella, and Alcelaphus. Aquatic animals included a wide variety of fish indicative of both deep and shallow water environments. Avian remains as well as a preponderance of Clarias spp. suggest, however, that shallow water areas were critically important resource centers.

Around 5000 BC Nile floods waned and no longer fed into the lake (Butzer and Hansen 1968; Wendorf and Schild 1976). This time period also marked the onset of an interval of increased aridity. The lake, lacking the influx of Nile water, evaporated to a very low stage or disappeared altogether. Concurrent with the demise of lake resources, the Fayum B culture disappeared. When Nile floods again reached a level of magnitude great enough to influence Birket Qarun water levels, a new cultural complex referred to as Fayum A, one dependent upon food production rather than food gathering, occupied the depression. The presence of Tetraodon and Lates recovered from Fayum A sites suggest that the aquatic fauna quickly recolonized the lake, returning it to a productive resource area.

Environmental changes to a more xeric environment served to diminish the predictability of Fayum resources, eliciting an adaptive response by the area's human inhabitants. The archaeological evidence compiled from several independent studies (i.e., Caton-Thompson and Gardner 1934; Wendorf and Schild 1976; Wenke et al. 1983; Kozlowski 1983) appears to demonstrate that adaptation to environmental change was in the form of technological change coupled with a change in population aggregation. This change in aggregation has been interpreted by Wendorf and Schild (1976) as an abandonment of the area.

Studies pertaining to the characteristics of Nile floods (Said 1975) depict flood magnitudes as an unpredictable phenomena. Local environmental conditions dependent upon Nile flood waters would thus be unpredictable as well. Human groups living in environments

characterized by an unpredictable resource base are usually best served by a procurement strategy classified as being generalized. Consequently, a large variety of resources are exploited; if one source becomes nonproductive, energy can be shifted towards the exploitation of alternate resources. The Fayum B culture has been referred to as having practiced such an exploitative strategy. Fayum A, on the other hand, is considered to have possessed a specialized resource base (cf. Wendorf and Schild 1975; Kozlowski 1983; Caton-Thompson and Gardner 1934). As both groups lived in the same environment characterized by the same degree of unpredictability, it seems contrary to ecological theory that a specialized economy could have become firmly established under the same conditions merely 1000 years after the apparent disappearance of a generalized economy.

An investigation comparing the recovered faunal materials from Fayum A and B sites was conducted as a means by which to better understand the procurement strategies practiced by both cultural entities and to establish whether or not a specialized system did indeed prevail over a generalized strategy in the Fayum.

Examination of the recovered fauna from Fayum A sites indicates that they exploited the same variety of resources as did the Fayum B culture (Table 4, p. 73). Faunal remains identified from both Fayum A and B sites were composed of large numbers of Clarias spp. and avian taxa indicative of shallow water regimes. Increased lake levels would have increased shallow water area and provided a habitat abundant in fish and waterfowl. These animals offered a reliable resource as long as high

lake levels were maintained. In addition to shallow water resources, the identified Fayum A fauna also included considerable numbers of deep water fish. This demonstrates the ability of both groups to utilize the deep open waters of Birket Qarun in order to exploit these taxa. With the exception of the presence of domesticates in Fayum A assemblages, all other aspects of the resource base as judged from faunal studies suggest the Fayum A culture was not dependent on a specialized economy but on a generalized one, augmented by domesticates.

A study of the seasonal growth cycles in Clarias pectoral spines indicated that Fayum B peoples exploited the shallow water area during a seasonal temperature cycle indicative of modern Egypt's late-spring or early summer and again in the summer/fall period. Avian remains suggest that Fayum B groups also occupied the area at sometime during Egypt's cooler (winter) months. An assessment of seasonal indicators recovered from Fayum A sites depicts a procurement pattern extremely similar to the earlier Fayum B culture. That is, a late-spring or early summer collection period for Clarias followed by a second Clarias collection period in the summer/fall. Avian remains represent birds that were winter visitors to the Fayum area.

It should be noted that these findings establish only a framework delineating several points in time when the area was certainly occupied. Whether or not Fayum inhabitants stayed in the area between these collection periods as represented by the presence of various seasonal indicators, or they migrated to the area staying only long enough to exploit these resources, is unknown.

A possible criticism concerning the methodology behind the seasonal dating of Clarias spp. might be that conditions attributing to fish growth differed between Fayum A and B times or between modern and prehistoric times. However, a strong correlation was demonstrated to exist between fish growth and seasonal temperatures. In turn, temperature, as ascertained from fish bone apatite, attained similar yearly averages during both Fayum A and B times. Furthermore, comparisons of diatomites recovered from modern Birket Qarun, the Fayum B Premoeris Lake, and the Fayum A Lake Moeris suggest that lake temperatures were similar for all three time periods (Aleem 1958; Boraey 1980).

Questions may also arise as to the reason for a late spring-early summer collection date for Clarias; up to this time Clarias collecting has been considered a late summer or early fall activity. In Chapter 3 it was suggested that members of this genus, because they are opportunistic feeders, may have aggregated in large numbers during late spring to take advantage of prey species which are known from certain parts of Egypt to spawn at this time. Opportunism, however, characterizes Clarias breeding habits as well as its feeding habits (Bruton 1979). Bruton (1979) presents evidence that these fish can develop and hold mature eggs for a long period of time. When conditions become favorable, the eggs are laid and fertilized. Specimens of Clarias taken by this author contained mature eggs as early as April, even though Clarias spawning is not considered to commence until the annual period of inundation in August or early September. Such an opportunistic strategy would be well adapted to unpredictable desert conditions. Increased

precipitation during the early Holocene may have been a possible impetus for Clarias aggregation in the late-spring early summer. Seasonal rains are known to trigger the onset of spawning behavior in Clarias living in Lake Victoria (Greenwood 1966). Precipitation in the Fayum during the late spring could provide the proper requirements needed for Clarias spawning as well as that for Tilapia and other species preyed upon by Clarias. Wendorf and Schild (1976) have offered another possible explanation. They believe that fishing activities were conducted during seasonally low lake levels. This period of time would correspond, based on modern Nile floods, to a late spring or early summer collection date.

Briefly, to summarize the results presented thus far, it has been demonstrated that:

1. Environmental conditions were similar during Fayum A and B occupations.
2. Identified faunal remains recovered from Fayum A and B sites show close similarities in taxonomic composition.
3. Assessment of seasonal indicators show a marked similarity in the time of year particular resources were utilized.

Fayum A and B appear to have possessed a similar procurement strategy with regards to the collection of Clarias, several avian taxa, deep water fish, and perhaps to some extent the endemic terrestrial fauna of the area. Nevertheless, Fayum A lithic technology, in spite of the similarities in resource utilization and seasonal procurement strategies, is drastically different from its Fayum B predecessor (Wendorf

and Schild 1976; Janet Long, personal communication 1985). So different in fact that some scholars (Wendorf and Schild 1975, 1976) believe the 1000 year hiatus between Fayum B and A too short to allow for the development of a Fayum A lithic technology from one such as that possessed by Fayum B people.

Disregarding for the moment the short span of time between Fayum A and B assemblages, one possible response to environmental change as outlined in Chapter 1 is technological innovation. Changes in technology, one would presume, would be correlated with different or more efficient exploitative strategies. Consequently, because Fayum A has been considered to have possessed a specialized economy, in this case one dependent upon domesticates, an argument for adaptive technological change seems, superficially at least, to be justified.

Although conclusions regarding the analysis of lithic materials recovered from Fayum sites are still pending (Janet Long, personal communication 1985), it appears that the technological change from Fayum B to A cannot be related to changes in the exploitation of fauna. Results from the analysis of the Fayum fauna suggest that the two cultural groups, although possessing radically different lithic traditions, were quite similar in exploitative strategies, casting doubt upon references pertaining to Fayum A groups as having been specialized sedentary agriculturalists. Wendorf and Schild's (1975, 1976) belief that Fayum A represents an immigrant group possessing different cultural affinities than the Fayum B inhabitants appears to be the best explanation at this time.

The terms "generalization" and "specialization" used throughout this study as classificatory terms reflecting Fayum A and B procurement strategies are not discreetly definable entities but rather represent two extreme positions of a continuum. Referring to Fayum B as generalized and Fayum A as specialized implies that these cultures occupied the extreme positions of the continuum. Faunal evidence has demonstrated that the Fayum A sites possess the remains of a wide variety of taxa reflecting a more generalized resource base than the term "specialized" allows. Analysis of faunal remains indicates that the Fayum A groups practiced an exploitative strategy not much different than that of the Fayum B group.

The importance of domesticate fauna to the Fayum A diet, unfortunately, cannot be accurately estimated from their presence in the faunal assemblages, but changing relative frequencies and a strong presence of wild fauna suggest that domesticates offered merely another resource to be utilized in an overall generalized procurement strategy. In fact, with the addition of domesticates, Fayum A inhabitants could be considered to have possessed a wider resource base than that of Fayum B and thus better adapted to the unpredictable environment characteristic of the Fayum Depression. Fayum A groups, rather than being depicted as sedentary food producers, may have led a life style similar to what we currently attribute to nomadic pastoralists, with a subset of the group or perhaps the entire group moving from area to area to exploit grazing lands as well as actively exploiting the various other resources in the area.

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APPENDIX

MAMMALIAN OSTEOMETRICS

Measurements of identifed mammalian specimens follow the procedures and nomenclature prescribed by von den Driesch (1976). All measurements are presented in millimeters. A minus sign (-) after a measurement indicates that the measurement was based on an eroded or otherwise altered bone.

Site 2--Fayum B

Taxa	Element	Measurement
Lepus sp.	scapula(head)	LG=9.4
		GLP=10.1
Lepus sp.	innominate	LAR=10.0
		LA=11.9

SITE 1--Fayum A

Canis sp.	mandible	4=76.2-
		7=44.0-
		10=17.0-
		14=83.3-
		18=46.5-
Canis sp.	mandible	10=37.6
		13=L 22; B 8.5
		14=22.3
		19=22.4
		20=11.0-

Site 2.

Canis sp.	mandible	19=11.0
Canis sp.	axis	LCDE=41.4
Canis sp.	scapula	LG=21.3
		BG=18.0
		GLPE=10.1
Canis sp.	tibia	BD=22.8
Canis sp.	astragalus	GL=25.0
Canis sp.	metatarsal II	GL=64.6
		BD=7.5
Canis sp.	metatarsal V	GL=69
		BD=7.7

Site 1--Fayum A

Gazella sp.	m2	B=14.5
Gazella sp.	m3	B=12.7
		L=21.5
Gazella sp.	atlas	GL=31.5
		BFED=52.2-
Gazella sp.	scapula	GLP=31.5
		LG=24.8-
		BG=18.5-
Gazella sp.	scapula	GLP=44.0-
		LG=38.0-
Gazella sp.	humerus	BD=39.5
		BT=36.1
Gazella sp.	humerus	BD=39.0-
		BT=36.0
Gazella sp.	radius	BP=31.6
		BFP=30.4
Gazella sp.	radius	BP=25.2
Gazella sp.	radius	BP=41.3
		BFP=37.0
Gazella sp.	astragalus	GLM=25.8
		GLI=27.2
		DI=15.9
		BD=18.6
Gazella sp.	phalanx I	GL=37.0
		PP=12.1
		BD=11.0
		SD=9.0
Gazella sp.	phalanx II	GL=39.4-
Gazella sp.	phalanx	GLPE=50.0
Gazella sp.	phalanx	LD=50.0

Site 2--Fayum B

Gazella sp.	femur	DC=15.6
Gazella sp.	tibia	BD=20.0
Gazella sp.	patella	GB=28.3
		GL=44.4

Site 3.

Gazella sp.	humerus	BT=38.5-

Site 1--Fayum A

cf. Alcelaphus	P2	B=6.0
		L=7.7
cf. Alcelaphus	scapula	LG=52.7-
		BG=33.7
cf. Alcelaphus	radius	BFD=32.2
		BD=34.2
cf. Alcelaphus	calcanuim	GL=69.0
		GB=24.0
cf. Alcelaphus	phalanx II	GLPE=36.0
cf. Alcelaphus	phalanx II	GLPE=36.8
cf. Alcelaphus	navicular	GB=46.1

Site 2--Fayum B

cf. Alcelaphus	astragalus	DM=26.5
		GLI=44.4
		BD=29.0

Site 3--Fayum A

cf. Alcelaphus	ulna	DPA=43.7
		SDO=33.3
cf. Alcelaphus	tibia	BD=43.5
		DD=29.0
cf. Alcelaphus	tibia	BD=41.3
		DD=30.7

Site 1--Fayum A

Ovis/Capra	maxilla	23=24.1
Ovis/Capra	p4	B=9.1
		L=15.3
Ovis/Capra	p4	B=7.6
		L=11.0
Ovis/Capra	m2	B=8.7
		L=13.0-
Ovis/Capra	m2	B=7.8
		L=17.7
Ovis/Capra	m2	B=9.0
		L=14.9
Ovis/Capra	m2	B=9.6
		L=17.0
Ovis/Capra	m3	B=9.0
		L=23.0
Ovis/Capra	m3	B=8.4
		L=25.1
Ovis/Capra	m3	B=9.3

Ovis/Capra	m3	B=9.3
		L=25.4
Ovis/Capra	m3	B=9.0
Ovis/Capra	m3	B=11.0
Ovis/Capra	m3	B=9.2
		L=23.6
Ovis/Capra	m3	B=9.7
Ovis/Capra	m3	B=10.0
Ovis/Capra	m3	B=9.0
		L=24.7
Ovis/Capra	m3	B=9.9
		L=24.7
Ovis/Capra	m3	B=9.9
		L=23.4
Ovis/Capra	m3	B=9.5
		L=25.0
Ovis/Capra	m3	B=8.0
		L=23.7
Ovis/Capra	mandible	9=28.4
		15b=25.0
		15c=17.1
Ovis/Capra	mandible	7=80.5
		8=54.9
		9=29.0
		15b=26.5
		15c=19.2
Ovis/Capra	mandible	9=24.9
		10=L 24
		B=8.3
Ovis/Capra	mandible	15b=24.7
Ovis/Capra	mandible	9=30
		15b=21.7
		15c=16.2
Ovis/Capra	mandible	15b=25.5
Ovis/Capra	mandible	7=79.9
		8=55.3
		9=20.9
Ovis/Capra	mandible	7=74.9
		8=55.3
		9=20.9
		15a=36.9
		15b=24.5
		15c=17.2
Ovis/Capra	mandible	8=54.6
Ovis/Capra	mandible	7=79.4
		8=54.6
		9=25.3
		10=L 22
		B 8.3

		15a=40.0
		15b=22.5
		15c=18.3
Ovis/Capra	mandible	9=23.0
		15b=23.3
		15c=11.1
Ovis/Capra	mandible	9=29.6
Ovis/Capra	mandible	9=25.8
		15c=16.7
Ovis/Capra	mandible	pmr=35.2
Ovis/Capra	mandible	pmr=37.5
Ovis/Capra	mandible	pmr=37.5
Ovis/Capra	scapula	BG=25.2
Ovis/Capra	scapula	BG=23.7
Ovis/Capra	humerus	BD=35.0
		BT=33.9
Ovis/Capra	humerus	BD=34.5
		BT=32.0
Ovis/Capra	humerus	BD=37.5
		BT=35.0
Ovis/Capra	humerus	BT=30.0-
Ovis/Capra	humerus	BD=34.5
		BT=33.0
Ovis/Capra	humerus	BD=31.1
		BT=30.0
Ovis/Capra	humerus	BT=30.5
Ovis/Capra	humerus	BT=33.3
Ovis/Capra	humerus	BD=32.0
		BT=29.1
Ovis/Capra	humerus	BD=34.4
		BT=30.0
Ovis/Capra	humerus	BD=35.5
		BT=31.2
Ovis/Capra	humerus	BD=35.5
Ovis/Capra	humerus	BD=30.0-
Ovis/Capra	humerus	BD=33.3
		BT=29.0
Oivs/Capra	ulna	BPC=22.0
		SDO=26.5
		DPA=30.7
Ovis/Capra	ulna	BPC=18.3
Ovis/Capra	ulna	BP=36.2
		BFP=33.1
Ovis/Capra	ulna	BPC=18.7
Ovis/Capra	radius	BFD=26.0
		BD=29.7
Ovis/Capra	radius	BFP=34.9
		BP=37.0
Ovis/Capra	radius	BFP=31.6
		BP=32.9

Ovis/Capra	radius	BFD=29.2
		BD=30.5
Ovis/Capra	radius	BFD=27.7
		BD=31.0
Ovis/Cspra	radius	BFD=23.6
		BD=28.6
Ovis/Capra	metacarpal	BD=28.5
Ovis/Capra	metacarpal	BD=29.9
Oivs/Capra	metacarpal	BD=29.6
		DD=11.7
Ovis/Capra	metacarpal	BP=23.0
Ovis/Capra	metacarpal	BD=29.4
Ovis/Capra	metacarpal	BD=26.1
Ovis/Carpa	metacarpal	BP=24.5
Ovis/Capra	acetabulum	LAR=27.4
		LA=37.2
Oivs/Capra	tibia	BD=29.0
		SD=12.7-
Ovis/Capra	tibia	BD=27.3
Ovis/Capra	tibia	BD=29.1
Ovis/Capra	tibia	BD=27.0
Ovis/Capra	tibia	BD=27.0
Ovis/Capra	tibia	BD=27.0
Ovis/Capra	tibia	BD=29.6
Ovis/Capra	tibia	BD=28.0
Ovis/Capra	tibia	BD=29.6
Ovis/Capra	tibia	BD=26.0
Ovis/Capra	tibia	BD=28.8
Ovis/Capra	tibia	BD=28.8
Ovis/Capra	tibia	BD=31.0
Ovis/Capra	tibia	BD=28.0
Ovis/Capra	tibia	BD=28.7
Ovis/Capra	tibia	BD=33.0
Ovis/Capra	tibia	BD=26.9
Ovis/Capra	tibia	BD=28.8
Ovis/Capra	tibia	BD=30.3
		SD=16.1
Ovis/Capra	tibia	BD=28.3
Ovis/Capra	tibia	BD=30.2
Ovis/Capra	tibia	BD=30.5
Ovis/Capra	tibia	BD=31.6
Ovis/Capra	tibia	BD=28.3
Ovis/Capra	tibia	BD=30.6
Ovis/Capra	astragalus	GLM=30.2
		GLI=31.7
		D=18.0
Ovis/Capra	astragalus	GLM=29.6
Ovis/Capra	astragalus	GLM=28.2
		GLI=29.0

Ovis/Capra	astragalus	BD=18.0
Ovis/Capra	astragalus	GLM=30.0
		GLI=31.2
		BD=18.9
Ovis/Capra	astragalus	GLM=32.0
		GLI=34.0
		BD=21.9
Ovis/Capra	astragalus	GLM=30.0
		GLI=31.8
		BD=22.2
		D=17.0
Ovis/Capra	astragalus	GLM=28.7
		GLI=30.5
		D=17.0
Ovis/Capra	astragalus	GLI=30.0
Ovis/Capra	astragalus	GLM=29.7
		GLI=30.2-
		DI=17.0
Ovis/Capra	calcaneum	GL=67.0
		GB=22.1
Ovis/Capra	calcaneum	GL=70.1
		GB=24.4
Ovis/Capra	calcaneum	GL=60.2-
Ovis/Capra	metatarsal	BD=27.0
Ovis/Capra	metatarsal	BD=18.0
Ovis/Capra	metatarsal	BD=27.0
Ovis/Capra	Phalanx I	BP=13.0
		GL=41.1
		SD=12.0
		BD=14.0
	Site 3.	
Ovis/Capra	tibia	BD=28.3
		DD=22.0
Ovis/Capra	tibia	BD=27.7
	Site 1.	
Bos	p4	L=16.0
		B=12.5
Bos	m3	L=41.2
Bos	m3	B=13.0
Bos	radius	BFP=73.6
		BP=81.7
Bos	metacarpal	BP=69.0
Bos	metacarpal	BD=48.0
		SD=32.5

Bos	metacarpal	BD=62.0
Bos	metacarpal	BP=67.1
Bos	tibia	BD=68.0
Bos	astragalus	GLM=62.3
		GLI=65.2
		DI=36.7
Bos	astragalus	GLM=62.3
		GLI=68.0
		BD=39.0
		D=37.0
Bos	calcaneum	GB=45.0-
		GL=157.6
Bos	calcaneum	GB=46.7
		GL=137.0
Bos	metapodial	BD=60.6
Bos	phalanx II	GLPE=41.3
		BP=34.1
		SD=23.0
		BD=25.7
Bos	phalanx II	GLPE=48.2
Bos	phalanx II	GL=43.0
		SD=28.5
		BP=33.3
Bos	phalanx	BP=31.4
Bos	phalanx	BP=27.1

Site 2.

Bos	m3	L=37.7
		B=11.0
Bos	scapula	GLP=89.0
		LG=71.4
Bos	tibia	BD=87.0
		DD=54.9

Site 3.

Bos	navicular	GB=50.5
	radius	BFP=7MA

VITA

Douglas J. Brewer was born in Yakima, Washington, on September 17, 1954. He attended elementary school in Colfax, Washington and graduated from high school in the city of Auburn, Washington. Mr. Brewer received his Bachelor of Arts degree, with distinction in anthropology, from the University of Washington in 1976. He completed his Master of Arts degree at Washington in 1980. From September 1979 to June 1981 he worked as a research associate at the University of Washington's Burke Museum.

Mr. Brewer reentered graduate school at The University of Tennessee, Knoxville, in September 1981. He received his Doctor of Philosophy degree in anthropology in June 1986.

The author is a member of Phi Beta Kappa, Phi Kappa Phi, The Society for American Archaeology, The American Research Center in Egypt, International Council for Zooarchaeology, and the Paleontological Society. Mr. Brewer will be employed by the University of Illinois, Department of Anthropology after graduation.