Neolithic Chipped Stone Assemblages from the Azraq Basin, Jordan and the Significance of the Neolithic of the Arid Zones of the Southern Levant.

Volume I

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I hereby declare that the work contained within this thesis was entirely composed by myself.

Douglas Baird

To Frances

Abstract

In section 1 a need to achieve a systematic understanding of the significance of developments in the Neolithic in the arid zone in the southern Levant is identified because of the implications for south Levant wide developments. In order to achieve these aims we must understand the nature of the relationships between arid and moister zone communities. Chipped stone provides one of the most significant media through which to investigate relationships and developments.

In section 3 the constraints of arid zone environments are discussed and evidence for environmental change assessed. The question of the appearance of pastoralism is raised. It is concluded that herded caprines have appeared in the steppe/deserts of the south Levant by the Early Late Neolithic. The question as to whether caprines were herded in the Late PPNB remains problematic. It is suggested that the evidence for caprine domestication in moister areas is questionable before the end of the PPNB. In section 4 chronology is explored.

In section 5 classification issues are investigated. The use of the type concept is eschewed. Attribute analysis is advocated. In section 6 the technology of Azraq Project Neolithic chipped stone assemblages is examined. Two periods of change were identified coincident with the rise and decline of naviform strategies. These changes occur from Early PPNB and in the Early Late Neolithic. Despite these changes there is considerable continuity, particularly in the character of naviform strategies. Techniques also indicate very considerable continuity. Regional traditions of technique exist within the Azraq basin. In section 7 the comparative status of Azraq basin Neolithic chipped stone technology is assessed. Regional traditions are reflected by techniques and the distinctive long term character of the Wadi el-Jilat and Azraq traditions thus emphasized. The Azraq Project sequence documents change and continuity in the early 6th M.b.c. in more detail than elsewhere.

In section 8 consideration of the tools highlights the appearance of distinctive burin site related assemblages in the Middle PPNB. Otherwise there is considerable continuity with only limited changes in the Early Late Neolithic. Assemblage composition is related to arid zone settlement patterns and adaptations.

Conclusions are that communities in the north of the arid zone of the southern Levant were relatively autonomous, but not independent of their moister zone neighbours. Developments in each zone thus have implications for an understanding of developments in the other. There is considerable continuity from PPNB into the Early Late Neolithic in the Azraq basin which probably reflects continuity in communities exploiting these areas. Changes may well relate to the increased importance of pastoralism. It is suggested that this phenomenon is south Levant wide and that explanations of developments at the end of the 7th M.b.c. must be framed in the same terms for the whole area. Changes at this time can no longer be seen as dramatic as they once were.

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SECTION 1.

INTRODUCTION.

There are several reasons to investigate the evidence of activity in the arid zone bordering the better watered areas of the Levant during the Neolithic.

1) In theoretical terms the potential importance of events in the arid fringes of the Levant has been appreciated for some time. Binford pointed out the potential demographic stresses that might result, in areas such as the Levant, where strong contrasts might exist in the degrees of sedentism and mobility of neighbouring communities/groups of communities (Binford 1968). However, conventional views of the Neolithic have taken little account of activity in the arid areas (Mellaart 1975, Moore 1985). Only recently attention has focussed on these arid areas because of the accumulation of discoveries of Neolithic occupation there (section 2) and because of an interest in one key issue, that is the origin of the nomadic pastoralism (Bar-Yosef 1984; Köhler-Rollefson 1992) that today is the dominant land use in the areas. It is rare that human communities, of whatever size, function in complete isolation. Whatever the precise relationships between those exploiting the arid zone and those exploiting resources in more verdant areas, it seems unlikely that developments in one zone never had influences on those in another. It seems plausible that we may arrive at a better understanding of any developments if we appreciate in which way communities in each area were affected by such developments, if at all. The relationships between arid and moister zone communities, and the detection of developments in which each was involved, are key issues in this study. These issues have not been examined systematically for the periods with which this study is concerned (section 2).

Preliminary evidence has indicated that a very diverse range of subsistence strategies were practised by some groups exploiting these zones (sections 3.5, 3.6.4-.5 and 3.7). Attempts to characterize behaviour as framed substantially by subsistence modes must clearly be challenged if it can be suggested communities practised several modes (section 3.7).

A priori we can state a range of historical trajectories could characterize the behaviour of communities in the arid zones. 1) It may be that relatively independent communities were characterized by distinctive behaviour and practised a set of subsistence techniques and strategies peculiarly adapted to relatively arid areas. As new techniques arose they were adopted and adapted to the specific needs of indigenous communities, at the same time possibly promoting change to the social structure of those communities.

2) It may be that the exploitation of the arid zones was only one component in the adaptive strategies of groups also functioning or based in moister areas. In this model changes in one area are merely part of a wider set of developments and behaviour of communities in the arid zone would be only one facet of varied behaviour patterns.

3) In historical terms either situation 1 or 2 pertained throughout given periods, or situation 2 replaced situation 1 or *vice versa*.

Key factors in resolving such issues will be 1) an ability to determine the broad nature of the relationships between communities in more verdant areas and in the arid zone. 2) Secondly they will involve an ability to determine the nature of changes of behaviour by groups in more verdant areas, the nature of changes of behaviour by groups in the arid zones, and the degree of correspondence between such changes in behaviour. These factors are clearly inextricably entangled.

A key issue that has concerned researchers is the introduction of pastoralism to the arid zones. For this research pastoralism is taken to mean only the raising of domestic animals (Meadow 1992, 262). In 1984 Bar-Yosef envisaged the acculturation of small hunter-gatherer groups in the arid zones as a result of pressure from expanding farming-herding communities in moister areas (Bar-Yosef 1984, 145-6). More recently Köhler-Rollefson (1989; 1992, 15-16) has envisaged the segmentation of communities in the moister zone because of the environmental impact of herd expansion on habitats around permanent communities. This scenario envisages the introduction of herding into arid zones by components of permanent communities in moister areas. Various permutations of these hypotheses could be developed, in their basic form each represents a concrete example of the alternative scenarios for all change in the arid zones outlined above. For Bar-Yosef then scenario 1 (see above) persists and for Köhler-Rollefson scenario 2 replaces scenario 1.

Certain concepts find frequent usage in discussion of contrasts between more arid and more moist areas and in the behaviour of communities exploiting these areas. It is impossible to prove or disprove sedentism, or mobility in settlement location, from archaeological evidence alone. This arises because it may be possible to demonstrate the presence of groups at a specific period of the year, but very difficult to do it for every month of the year **over several years** of occupation. Mobility is *a priori* impossible to prove because the absence of a group at a particularly time involves an absence of evidence, but absence of archaeological evidence is no guarantee of an absence of people. Assumptions are always required. It is the unpredictability of resources in the arid zones that allow the assumption of mobility. No particular model of mobility can be assumed, however. So called seasonal rounds cannot be correlated with the seasons, much movement could take place within one season, little movement over several others. It may be that resources might support year round occupation over several years in certain locales. What is at stake is not an absolute definition of mobility, but a relative one. Settlement permanence must also be used as a relative concept. The concepts of permanence and sedentism are closely intertwined. Within a sedentary and permanent settlement system, eventually all communities will relocate and some components of communities may relocate relatively frequently. Components of communities may be absent from a permanent settlement context on a regular basis for lengthy periods. As a working definition it is valuable to define permanent settlements as those that span the existence of at least one generation and sedentary communities must be seen as those which have a permanently located settlement base at which components of communities are located with considerable regularity.

Essential to the case for the mobility in settlement location and of communities in the arid areas of the Levant is that, inevitably, communities will have to move much more frequently, in such environments, than most communities in moister areas would. This is because resources are mostly seasonal, always relatively unpredictable, and rarely concentrated in one locale. Available moisture is the crucial factor. Perennial water resources are very rare, and usually limited, in the areas under discussion; if some might last over the whole year in one year, this might not be the case in another. Clearly available moisture is the key to man, animal, and plant distribution, cited here in order of species vulnerability to fluctuation in this critical resource. Given that the location and broad topography of the arid zones will not have changed dramatically since the early Holocene their **relatively** arid status must be seen as a constant. From this follows the relative unpredictability of resources enunciated above.

Plainly, the degree of aridity in relatively arid areas in the past, and the spectrum of fluctuation in such states, must be documented if synchronic and diachronic variation in behaviour is to be examined in relation to variation in resources. As we will see the evidence for palaeoenvironmental reconstruction is slender (section 3.6). In these circumstances our datum can be only the relative aridity of the areas with which we are concerned. The modern circumstances of the zones supply us with information on the nature of constraints in such zones. It is necessary to consider a boundary of significance to demarcate the areas of interest. However, even in a modern context, as will be demonstrated in section 3, such boundaries may be imprecise and of limited significance. The view taken in this research is that the arid zones are those areas in which resources are less abundant and predictable than in their moister neighbours and that only incredibly dramatic climatic differences could alter these circumstances. The modern boundaries of these zones merely provide convenient reference points on either side of which we will search for contrasts in the behaviour of the communities exploiting the different areas. When steppe and desert areas are discussed it is obviously the modern setting that is being referred to, not the precise status of these areas in the past. Clear cut contrasts in settlement type (section 9.1.2.1), architecture (section 9.1.2.1), chipped stone tool types (section 9.1.2.2), ground stone (section 9.1.2.2), other aspects of material culture, and fauna (section 3.7.1) of Neolithic sites recovered in the modern steppe and deserts indicate the genuine nature of the contrasts in options for those located in relatively arid and those located in relatively moist areas.

To examine some of these options and the nature of changes in behaviour the evidence from several arid areas of the Near East must be examined in relation to :

1) palaeoenvironmental factors
2) interrelationships within the arid zone
3) interrelationships between arid and moister zones

4) change in subsistence strategies
5) other behavioural changes.

Whilst many Neolithic sites in the southern Levant have been investigated, few have been published in the detail necessary to explore these issues using the archaeological evidence on a comparative basis. This research focuses on the Neolithic sites of the central and south-western parts of the Azraq basin in eastern Jordan. Here the multi-period multi-disciplinary Azraq Project of Andrew Garrard has investigated a series of Neolithic and Epipalaeolithic sites. These provide a valuable arid zone sequence for the Neolithic covering the later 8th to the earlier 6th M.b.c., at least. Assemblages in which chipped stone is plentiful are common to arid and moister zone sites in both aceramic and ceramic Neolithic periods. Ceramics are absent or very scarce on arid zone sites in the ceramic Neolithic periods. Other components of material culture apart from chipped stone are encountered with much less frequency than chipped stone. Chipped stone thus provides the most effective single medium in which to investigate issues of interrelationships between and changes in the behaviour of communities in arid and moister areas. Clearly no single component of material culture will inform upon all aspects of behaviour, but logistics demanded concentration on one aspect. Chipped stone seemed to be provide the most rewarding area of study for these periods and places in relation to the issues of concern.

Certain problems are common in using chipped stone assemblages to reconstruct the nature of relationships between communities. Classically framed this is the functional/cultural dichotomy of Bordes and Binford (Binford 1973). Variation in the frequency of occurrence of particular tool classes may well reflect functional, that is adaptive, and/or cultural, that is community specific traditions of behaviour. The burin sites (sections 2.2 and 2.6.2) and associated assemblages are a reflection of just this phenomenon. In order to look at community specific traditions of behaviour, community defined here at an unspecified level, the actual nature of the tool classes themselves and the strategies and techniques of production had to be studied. In particular, it was felt that a detailed study of production technology on a systematic basis might offer significant insights into community interrelationships. In studies of ceramics too it has become appreciated that there are alternative ways to produce broadly similar artifacts and these might indicate much about communication between artifact producers. This is because items of similar appearance may be replicated without face to face interaction. It seems unlikely that relatively precise replication of methods and techniques, the invisible aspects of a finished product, is possible without such direct communication. In these terms the most idiosyncratic aspects of production are likely to be the most sensitive to the presence or absence of such communication - in a broad sense community traditions. In the case of chipped stone these may be found in areas concerning technique (section 6.8) or detailed specifics of reduction strategy (sections 6.3-6.5). Tools, too, may tell us about traditional practices (section 8). However, if we are to understand what the variations in the frequency of tool types may mean it seems most appropriate that we understand the nature of what it is that varies (section 8.1). Thus considerable emphasis was placed, in this research, on an analysis of the detailed evidence for production technology (section 6) and a distinctive approach was developed, in order to understand variation in tool assemblages, in terms other than the variation in the proportion of the most distinctive types (sections 8.1-8.9). In undertaking this task the nature of types (section 5) and the nature of the types themselves (sections 8.1-8.9) had to be assessed. This approach, in particular, attempted to redress the balance in reference to the retouched blade-bladelets and flakes that have, in the past, at least in Levantine Neolithic industries, been classed as miscellaneous or otherwise retouched tools and which often make up the bulk of tool assemblages. It seems impossible to genuinely comprehend inter-assemblage variation if substantial parts of each assemblage remain poorly understood. The result of these decisions was a detailed attribute analysis of the most informative technological aspects of each assemblage (section 6) and of certain contextually controlled tool samples (section 8). The logistics of this investment in attribute analysis, which followed on from an initial categorisation, as far as the research programme of this thesis was concerned, meant that other aspects of research were constrained.

These constraints were imposed, partly by the size of the chipped stone assemblages recovered, and partly by the stage of research that the Azraq Project has reached. Final analysis of the stratigraphy is still required. The information about the sites, in particular their stratigraphic development, accrued from three sources. As assistant director and then field director of the Azraq Project the author had a degree of responsibility for the progress of the excavations and clear knowledge of the nature of the results of the fieldwork, the product of the interaction of many. He has analyzed also the records of this field work to establish the key developments on the sites. Further, Dr. Garrard made available the results of his own analyses of the stratigraphic record, current at the time of composition of this thesis. As a result of these factors, and only where the record is absolutely clear, the author has established an outline of the main developments in a manner that ensures that any changes in our perceptions of the sites through further work should not affect this outline. In the future a contextually based and detailed intra-site analysis of the chipped stone assemblages are envisaged. Collection policy for the chipped stone consisted of the sieving of all deposits through a 5 mm. mesh, except those from the surface of Azraq 31. For extensive contexts, which were believed to represent the primary occupation of a well defined entity, collection was carried out by grided units, dividing up each 'naturally' defined context (these we termed spatial units). It was felt that, until final post-excavation analysis of the excavation record was complete, and that until all other artifact and ecofact analyses from the sites were complete, that a detailed contextual analysis would be inappropriate. This, and the logistical priorities imposed by the research aims espoused above, precluded any contextual analysis, other than of the broadest type, essentially chronologically oriented, at this stage.

Because of the size of the collections only samples of each assemblage could be studied and only samples of those samples could be subject to attribute analysis. The policy behind this sampling was to study material from discrete contexts in each identifiable occupation phase. To effect this only uncontaminated, unmixed and well stratified contexts were chosen, where for a variety of reasons the chipped stone assemblage seemed most likely to represent an unmixed collection of material manufactured, used and deposited contemporary with the period of occupation. Questions can exist about the nature of even the most reliable contexts from sites. Where the nature of the contexts is problematic this is indicated. By concentrating on fewer, but relatively secure contexts, the most effective use was made of the need to sample.

The pretensions to originality in this research are, therefore, threefold. They consist of 1) systematic comparisons of developments in behaviour in the arid and moister zones, in an attempt to achieve a broader understanding of change in the Neolithic as a whole, rather than as part of just one issue particularly relevant to the arid zone such as pastoralism (section 2). 2) There is involved, also, an attempt to place an understanding of complete tool assemblages, as part of total chipped stone assemblages, on a systematic and new basis. 3) There is a presentation of new data about which original conclusions are drawn.

SECTION 2

HISTORY OF RESEARCH INTO THE NEOLITHIC OF THE ARID ZONES.

2.1. Earliest research. 1905.

In his wide ranging investigations of the development of, and interrelationships between, Egyptian and Palestinian civilizations, Petrie carried out work in Sinai. This included the investigation of what we now appreciate to be an aceramic Neolithic site by Currelly (1906). This has proved to be of a classic type for sites of this period in Sinai, but given the very limited nature of prehistoric investigations in the Mediterranean zone at the time its comparative status and potential significance were not appreciated. No significant conclusions were drawn therefore.

2.2. Chance discovery and first recognition of the burin site phenomenon. 1930's.

Picnickers chanced upon the Wadi el-Jilat Neolithic and Epipalaeolithic sites. This wadi is a tributary of the Wadi ed-Daba and when the sites were investigated and excavated by Waechter (Waechter and Seton-Williams 1938) they were designated Wadi Dhobai A-H . A major sounding was carried out at the aceramic Neolithic site of Wadi Dhobai B re-excavated by the Azraq Project as Wadi el-Jilat 13. Classic Jilat and desert Neolithic style architecture was revealed. This was the earliest recognition of a Neolithic chipped stone assemblage whose tool component was dominated by angle burins, particularly on concave truncations. Other sites of this type were recognized in Wadi el-Jilat, notably Wadi Dhobai A (excavated by the Azraq Project as Wadi el-Jilat 26 = J26) and Wadi Dhobai C (J7), Wadi Dhobai D (J25). Because of the apparent association of these burins with Byblos points, on an aceramic site, this assemblage was dated to the PPNB and this tradition looked upon as a regional, possibly desert variant of the PPNB and christened the Dhobaian.

2.3. Aerial encounters. 1930's.

There were chance sitings from those flying the mail routes, Amman to Baghdad, of complexes of structures in the *harra* (Maitland 1927). It was suspected that some were prehistoric. They made little impact on conventional views of the prehistoric Levant.

2.4. Extensive surveys. Late 1940's and 1950's.

Field's North Arabian work.

This encompassed survey in northern Saudi Arabia, Jordan and western Iraq. Chipped stone tool concentrations were observed, many clearly Neolithic (Field 1960). This included the discovery of the first classic burin sites dominated almost exclusively by burins with no or little occupational (cultural) deposit and no structures. A relationship with the Dhobaian was inferred by Garrod (Field 1960), but because these assemblages did not have classic PPNB elements, this phenomenon was given a separate name the Wualian. This distinction supplies the roots of a significant dichotomy that still has relevance today. That is the appreciation that the phenomenon represented more than an arid land adaptation *per se*. This distinction involved a clear circumscription of the problems of chronological and cultural relationships inherent in dealing with assemblages with such limited/specific characteristics.

This distinction embraces some of the significant functional and chronological characteristics of the burin site phenomenon. It separates sites reflecting limited and specific activity sets from those with more variable elements and or of different time periods (section 8.12.10).

In 1957 Rothenburg carried out preliminary survey in Sinai which suggested a rich prehistoric record including Neolithic sites (Rothenburg 1979, 110) which encouraged him to conduct more intensive survey after 1967.

Numerous Neolithic arrowheads were recovered by unsystematic survey in the Negev in the 1960's and 1970's leading to some recognition of the potential density of Neolithic settlements in such areas (Burian and Friedman 1965; 1975).

2.5. First arid zone multi-disciplinary prehistoric project(s).

These were exemplified in the 1960's by Marks' (1977) work in the Negev. The aim of such projects was to look at environment-human interaction over lengthy time periods in the arid zones, which might be particularly sensitive to long term environmental changes. Henry's (1982; 1985; 1988) work in the Hisma, Garrard's work in the Azraq basin (Garrard and Stanley Price 1975-77; Garrard *et al* 1985; 1988a; 1988b), and Clark's (*et al* 1987) project in the Wadi el-Hasa are the direct descendents of Marks' Negev Project with very similar aims.

In Marks' project little later prehistoric occupation, i.e. of the Neolithic, was encountered, and only limited exposures at 1 PPNB site, Nahal Divshon, were achieved (Servello 1976). The potential significance of arid zone adaptations in the PPNB and later Neolithic was not considered. However, a new transitional Epipalaeolithic-Neolithic arid land phenomenon was observed, the Harifian, which shared many of the features of the early Neolithic (PPNA), but in an arid setting (Marks 1975). This provided the first real challenge to investigate the significance of arid zone communities for the understanding of one of the major processes in the Neolithic - the origins of agriculture. this challenge h was not, at the time, perceived (Henry 1992, 219-220).

2.6 Targetted research projects.

Apart from the large inter-disciplinary multi-period projects which have followed on from Marks' work in the Negev, 2 projects have focussed largely or completely on the early Holocene prehistory of areas of the south Levant.

2.6.1 Investigations of the Neolithic of Sinai.

The first of these was a project conceived by Ofer Bar-Yosef to investigate the Neolithic of Sinai (Bar-Yosef 1981c; 1984). The purpose of this project was specifically to investigate the relationship of arid and moister zone societies in the Neolithic in order to understand the development of nomadic pastoralism (Bar-Yosef 1984, 145-6). The preliminary achievements of Bar-Yosef's project seem to relate to the distinctive nature of arid zone settlements with their characteristic structures reflecting a mobile adaptation. However, the tentative seasonal round envisaged by Bar-Yosef (1984, 157-8) may not withstand scrutiny in the light of the detailed evidence for seasonality from Ujrat el-Mehed, for example (Dayan *et al* 1986). Bar-Yosef suggests use of the same broad region in southern Sinai by Neolithic groups, rather than moves outside this region on the basis of unspecified observations (Bar-Yosef 1984, 157-8). This would suggest relatively autonomous populations (section 1), although with links with other PPNB communities to the north.

2.6.2 Investigations of the prehistory of the Black Desert.

Betts (1986; 1987a; 1987b; 1988a; 1988b; Betts *et al* 1990; 1991) has conducted 2 survey and excavation projects in the *harra* and *hamada* to its east, the Black Desert survey and the Burqu' project, both focussed on the early and middle Holocene. Major discoveries included the density and frequency of burin sites (she recovered 82 in the Black Desert survey alone) and of desert kites (Betts 1987a). Betts' burin sites are, of course, the Wualian of Garrod. They are characterized by tool assemblages completely dominated by burins, of which the dominant component is truncation burins. Occasional arrowheads, tile kni~~f~~ves and bifacials were also recovered on these survey sites and for the first time she identified drills on burin spalls at Jebel Naja (Betts 1987a; 1987b). Her most significant conclusions were that burin sites were probably Late Neolithic and associated with pastoralism and that the kites were animal traps for gazelle hunting in use from the PPNB onwards (Betts 1987a). Each of these inferences had far-reaching consequences. Based on an absence of supposed evidence relating to agriculture and hunting, that is no sickles or projectile points, on a supposed contrast with clear PPNB sites in terms of site location, the burin site locations coinciding with the locations of the camps of modern pastoralists, and the absence of occupation deposits of much depth, she intimated that the burin sites might reflect the presence of the camps of Late Neolithic pastoralists (Betts 1987a). This question will be discussed in the light of the evidence of the tool assemblages from PPNB and Late Neolithic sites in Jilat and Azraq (sections 8.12.10, 9.1.2.2 and 9.2.2).

The question of the date of the kites will be addressed here, as it has had a considerable acceptance and impact in the literature. It has been used as a significant strand of evidence relating to the behaviour of Neolithic groups in the steppe (Bar-Yosef and Belfer-Cohen 1989, 66-67). The evidence for their assignment to the Neolithic is slender. Their use in the period of Safaitic inscriptions is attested by the inscription on the cairn of Hani which illustrates a kite in use, whether for hunting or herding is unclear (Helms and Betts 1987). Kite-like structures were in use for gazelle hunting in the 19th century, those described reflect the character of the environment in which they were constructed (Rothenburg 1979, 116; Helms and Betts 1987). The evidence for Neolithic use is far from conclusive. A number of PPNB sites are incorporated into kite walls or are within kite enclosures (Betts 1988, 13). If the kites were hunting traps it is unlikely that the settlements were occupied when the kites were in use, otherwise the animals would not have been trapped successfully. In the Black Desert where kites are densely distributed (Helms and Betts 1987) many wall and corral systems intersect. Often these walls plainly make use of earlier features; complex palimpsests are clearly present. Prehistoric rock art is incorporated into walls (Betts 1988, 13), but then so is art associated with Safaitic inscriptions; such incorporation could have taken place at any period. At Dhuweila itself there is supposedly stratigraphic evidence for the Neolithic date of kites (Helms and Betts 1987). Until detailed publication of Dhuweila is achieved we will not be able to make a final assessment. However, a wall which connects with a kite, but is itself not necessarily part of a kite, or indeed contemporary with a kite (Betts 1988, fig. 4), runs on the surface **over** PPNB deposits to meet the prehistoric structure. There is no bonding and the structure is not built over the wall, they merely join (personal observation and Betts pers comm.). A kite wall to the north of the site peters out as it approaches the site (Betts 1988, fig. 4). Betts (1988, 13, fig. 4) suggests it was disturbed during the construction of the structure. Given the fact that it is a surface feature, the presumption that it was robbed rather than peters out and that this must have occurred during the occupation of the structure is difficult to verify. Other evidence is circumstantial. This includes the number of Neolithic point types recovered from the vicinity of kites and a collection of 4 probable bifacials from a kite hide. The evidence of surface finds is clearly far from conclusive. Survey focussed on kite areas to help with dating, comparative data on chipped stone densities, particularly points, in other locales suitable for hunting, but lacking kites is not available. In these circumstances it is difficult to know whether the degree of association is unusual. The cache of Neolithic-like bifacials in one kite hide is the most convincing piece of evidence of a Neolithic date for kites. They could, of course, have been placed there before the kite was constructed and then exposed by deflation or after the kite was constructed, for some enigmatic purpose, long post-dating their manufacture. This combined evidence is insufficient to assign kites to the Neolithic, especially when we know they were in use from the Safaitic period, probably until the 19th century A.D.

Section 2.7. Summary.

Evidence of Neolithic occupation of the arid zones has accumulated, for the most part, in a haphazard manner. As a result no systematic attempt has been made to investigate relationships and interaction between arid zone and moister zone Neolithic communities or to assess the ramifications of developments in the arid zones for an understanding of the Neolithic of the whole of the southern Levant (section 1). As outlined in section 1, that is, in part, what this thesis attempts.

SECTION 3.

PHYSICAL GEOGRAPHY, CLIMATE, RESOURCES AND SUBSISTENCE

Section 3.1. General situation.

The Levant as a whole, and the southern Levant in particular, is a relatively arid region. Even within this region, however, there are steep gradients between relatively moist and very arid settings. Since this study is a study in human behaviour it is logical to define the arid areas in those terms which most profoundly affect(ed) human behaviour (section 1). Since agriculture had become established by the periods with which this study is concerned (albeit relatively recently) and the practice of agriculture was profoundly affecting the behaviour of contemporary communities, it seems useful to distinguish the arid zones as those areas where *reliable* dry farming cannot be undertaken. Differences of opinion seem to exist on the level of precipitation required, usually stated in terms of mean annual precipitation, for dry farming to be carried out in a reliable way. These opinions often reflect differences in local conditions where particular research is performed. Thus in north Mesopotamia 250 mm. is often quoted (Weiss 1986, 77; McCorriston 1992, 318) and Maisels (1990, 50) states that in fact 300 mm. is probably required for truly dependable dry farming. In the southern Levant 200 mm. is often quoted or observed (Garrard *et al* 1988b, 313). A key factor is the degree of inter-annual variability in rainfall. Where there is greater inter-annual variability the reliability of dry farming is obviously less and dry farming is only relied on in zones of higher mean annual precipitation. In fact in the southern Levant, where inter-annual variability in rainfall is less than in north Mesopotamia at the present time, and in the recent past, 180 mm. of mean annual precipitation probably represents the limits of reliable dry agriculture (Weiss 1986, 77).

This boundary, broad and imprecise as it must be considered, falls within the moist steppe vegetational zone. Dry steppe is usually considered to fall between 150 and 100 mm. of mean annual precipitation and desert vegetation is found, broadly speaking, where mean rainfall is less than 100 mm. per annum.

One of the most significant features of these broadly defined, low rainfall zones is the high degree of variability in frequency, quantity and location of the rainfall that does occur. In the southern Levant precipitation usually occurs as highly localized (Lancaster and Lancaster 1991, 125), intense, outbursts restricted to the winter months, November to April (Betts *et al* 1990, 1; Garrard *et al* 1988b, 313; MacDonald 1992, 15-16). Within the low precipitation areas rainfall does not necessarily decrease from north to south or west to east (Lancaster and Lancaster 1991, 128). Further, inter-annual variability is very high, for example exceeding 90% in eastern Jordan (Shehadeh 1985, 30). Dew fall can be an important addition to moisture in desert and steppe areas. In the Negev mean dew fall *per annum* between 1963 and 1966 was 33 mm. (Munday 1976, 11-12). However, this moisture is not effective for plant growth, as indeed much rainfall is not, although it is important as a source of moisture for animals whether gazelle or herded caprines (Lancaster and Lancaster 1991, 126).

Section 3.2. Physical geography.

Broadly speaking, these arid zones are found to the east and south of the areas of moist steppe and Mediterranean woodland which lie at the heart of the southern Levant (fig. 3.1). They encompass a variety of topographically and geographically defined areas with, as a consequence, varied rainfall and vegetation. To the east of the hill zone on the eastern edge of the Jordan rift valley low limestone hills and plateaux giving way to flat, extensive plains characterize the arid zones. South and east of the agricultural plains around Irbid, and on the foothills of the Jebel Druze a similar picture is seen. Within this area the Azraq depression and the south western part of its drainage system form the setting for the sites which are the focus of this study (fig. 3.2). As a result these areas are described in particular detail.

The Azraq basin (figs. 3.1 and 3.2) is a shallow depression covering 12,000 km.^{2}. It stretches from the southern fringes of the Jebel Druze in southern Syria to the Saudi Arabian frontier in the south and east. Here a narrow watershed separates the Azraq basin and the deep, wide Wadi Sirhan which runs south east into northern Arabia. The Azraq basin reaches to within 20 km. of Amman in the west. The elevation in the centre of the depression, around the fresh water springs and saline marshes of Azraq itself, is c. 500 m. above sea level. To the south, west, and east the edges of the depression are watersheds of between 600 and 900 m. above sea level. The southern part of the basin is the northern part of the *ard es-sawwan*, limestone plains covered with a flint reg. To the south west and west are low limestone and chalk hills forming a watershed with the westward oriented drainages. On their eastern edges these hills are also covered by a flint pavement, the result of deflation, but to the west steppe soils are anchored by a mat of grasses (Garrard *et al* 1988b, 317).

The steppe/desert boundary, marked by this contrast between the patinated flint reg and steppe soils and by the 100 mm. isohyet, runs through the centre of the Wadi el-Jilat, located in the south western fringes of the drainage (figs. 3.2 and 3.4). The Wadi el-Jilat runs north eastwards into the Wadi ed-Dabi which is one of the major wadi systems draining into the south western edge of the Azraq *qa*, that is mudflat, c. 55 km. to the north east (fig. 3.2).

The Wadi el-Jilat (henceforth Jilat) has a drainage catchment of 160 km.^{2} and lies at an altitude of between 755 and 965 m. above sea level. The valley has cut through Cretaceous and Tertiary limestones, chalks and marls. Within the central to eastern portions of Jilat a gorge has been cut through late Pleistocene marsh deposits and earlier, Pleistocene aggradational units (Garrard *et al* 1988a, 41). The former are dated to c. 14,000 b.p. by associated occupations (Garrard *et al* n.d.). The gorge has a Roman dam constructed across it and was thus fully formed by the first half of the first millennium A.D.

The centre of the basin is the Qa el-Azraq, an extensive mudflat which can flood up to 2 m. deep over an area 50 km.^{2} in wet seasons (Nelson 1973). As a result of the long term accumulation of salts the sub-surface aquifer is extremely saline (Garrard *et al* 1988b, 326). Fresh water, draining through the basalt flows to the north, issues as freshwater springs around the western and northern edges of the *qa* (playa). These springs feed extensive marsh areas covering, in the recent past, several square kilometres.

Immediately to the north and c. 45 km. to the east of Azraq itself is the *harra* (lava field). This consists of rolling limestone hills intersected by wadis and more extensive playas and covered by eroded lava flows, many of considerable antiquity, but some more recent (Vita-Finzi 1982, 24). The resultant spread of basalt cobbles gives this area a particularly rugged character and the appellation of the Black Desert. The high point of the *harra* the Jebel Ashaqif, north east of Azraq, c. 1800 m. above sea level, provides a watershed with south westward oriented drainage running into Azraq. The *harra* itself runs to the east of the Azraq basin into north western Saudi Arabia skirting the eastern edges of the Wadi es-Sirhan. In total the *harra* covers an area of 45,000 km.^{2} of which 11,000 km.^{2} are in Jordan (Helms 1981, 17).

To the east of the *harra* is the *hamada*, the southern part of which is called the Wudiyan. Here wadi systems drain across further limestone plains, some with flint reg, east to the Euphrates. At the lowest point of the interface between *harra* and *hamada*, is the, usually, perennial lake at Burqu'. This forms a sump for water draining from the basalt, particularly the Jebel Ashaqif to the south west and from Jebel Aneiza, through the major wadi system of Ruweished, to the south east.

The plains of the *ard es-sawwan* (the flint desert) run south of Azraq to the al-Jafr depression. To the west of al-Jafr these plains give way, in the Hisma, to extensive, and often deeply dissected, sandstone plateaux and massifs, demarcating smaller plains. Dramatic elevational contrasts over short distances characterize the Hisma (Henry 1982, 42). Drainage courses run westward into the Arabah or into the internal drainage system of the Jafr depression.

These areas form the eastern boundary of the Wadi Arabah, the continuation of the Jordan rift south of the Dead Sea. The base of the Arabah c. 300 to 200 m. below sea level is arid along its length. The high hills on the north eastern edges of the Arabah are the setting for orographic precipitation. This extends the areas where dry farming can be reliably practised in a long corridor, relatively far south, particularly in the high Edomite hills on the east central edge of the Arabah (fig. 3.1). Deeply incised wadis run into the Arabah from these mountains. Water sources in the Arabah depend on precipitation in the adjacent upland (MacDonald 1992). Precipitation in the Edomite highlands allows settlement in otherwise arid settings along its fringes, represented in prehistory by settlements at Basta and in the Wadi Fidan.

On the western edge of the Arabah is the Negev, an area of c. 12,000 km^2, with central limestone highlands around the Har Harif (elevations 450-1,000 m. above sea level) and surrounding plateaux dissected by water courses (Munday 1976, 9). Most drainage systems run westwards, but some run north east into the Dead Sea.

To the south of the Negev is the Sinai peninsula, an area of 61,000 km.^{2} with diverse topography and environments. A central spine of mountains and hills provide the principal topographic feature. Highest in the south, the St. Katherine's range of metamorphic and magmatic rocks reaches over 2000 m. above sea level and again provides elevational gradients of considerable significance for vegetation and animal life. Precipitation is highest in these high southern mountains. Drainage systems run east into the Red Sea and west into the Gulf of Suez. The central portion of Sinai is dominated by an extensive limestone plateau, with drainage systems running northwards. The northern part of Sinai consists of recent and fossil dunes, with isolated hilly and mountainous areas immediately to their south (Jebel Maghara, Jebel Yi'allaq). The limestone plateau of the Avdat stretches from the eastern edge of Sinai to the Harif hills in the central Negev. Mean precipitation throughout the peninsula is in the order of 20-120 mm. *per annum* (fig. 3.1).

Whatever the broad pattern of precipitation in the zones demarcated by the isohyets, the very diverse topography of these arid areas profoundly influence vegetation, water and other resources. The result is a mosaic of resources differentially distributed across the landscape. Their occurrence in this arid setting is, for the most part, made less predictable by the extreme variability of the rainfall characterising these areas.

Section 3.3. Distances and gradients.

Binford (1983) has emphasized the geographical scale at which the movements of some nomadic hunter-gatherers should be measured. Whilst not pre-empting any detailed discussion of the behaviour and subsistence strategies of PPNB and Late Neolithic groups in the arid zones, nomadic strategies would clearly be common in areas with highly variegated, unpredictable and limited resources that also typify the arid zones of the Levant. Indeed nomadic subsistence strategies almost completely dominate the exploitation of the areas being described today. In these circumstances issues of distance and scale take on particular significance, as do the gradients over which the contrasting and variegated resources are spread.

The transition from dry farming-moist steppe, through moist steppe, dry steppe and into the desert areas takes place over a very steep gradient in Jordan today. On the eastern fringes of the farming zone the isohyets are closely aligned (fig. 3.1). One can move from areas of over 200 mm. mean annual rainfall to those with less than 100 mm. over distances of 10-35 km. along the eastern edge of the cultivated areas of central Jordan and in the *harra* to the south of Jebel Druze (where higher rainfall occurs regularly further east). North and west of Azraq and Jilat the distances are slightly greater, in the order of 40-50 km.

In the south of Jordan, the Arabah and Sinai these gradients are more dramatic (literally as well as metaphorically) because of greater topographic contrasts. Thus in the northern Arabah over just a few kilometres one can move from areas 300 to 200 m. below sea level, whose saline soils and c. 65 mm. of mean annual rainfall support classic Saharo-Sindian desert vegetation (MacDonald 1992, 15-16), to areas several hundred metres above sea level where mean annual precipitation exceeds 200 mm. Areas able to support Mediterranean vegetation, with over 300 mm. of rainfall per annum, are at a distance of between 10 and 20 km. from the base of the Arabah. Such gradients are also common in the Hisma; in 10 km. one can move from areas 900 m. to 1400 m. above sea level traversing Saharo-Sindian, Irano-Turanian and Mediterranean vegetational zones

(Henry 1974, 42). Whilst no part of Sinai has precipitation over 200 mm., the varied topography also encompasses steep gradients. Although rainfall ranges from 20-120 mm. over most of the area it can be higher in parts of the high southern mountains resulting in distinct elevationally based contrasts over short distances (Bar-Yosef 1984).

One can give some idea of the relatively small scale of the territories over which nomadic groups would have had to move by comparing the distances involved with those regularly traversed by a variety of modern hunter gatherers and nomadic pastoralists. To traverse the *harra* from Azraq to agricultural areas just north of Jawa is c. 60 km. To cross the *harra* from Azraq to the regular water sources at Burqu' one travels just over 150 km. of rugged terrain. From Azraq to Amman (on the eastern edge of which Ain Ghazal is located) it is 80 km. From Jilat Amman, in its Mediterranean woodland setting, is c. 60 km. to the north west.

From Azraq to the al-Jafr depression it is c. 175 km. The Neolithic site of Beidha is c. 75 km. west of al-Jafr.

Beidha, one of the most southerly Neolithic permanent agricultural village communities thus far documented, is located in the Edomite hills near Petra, just east of the central Arabah. From Beidha it is c. 70 km. northwards to the south end of the Dead Sea, c. 85 km. southwards to the Wadi Rum on the southern edge of the Hisma, c. 40 km. westwards to Har Harif in the central Negev and 40 km. north westwards to Nahal Divshon in the centre of the northern Negev. The Neolithic sites located in the high southern mountains of Sinai are 200 to 250 km. south west of Beidha (fig. 3.5). Beidha is c. 150 km. south west of Jilat.

There are various sources of information that provide an intimation of the possible scale of movement of nomadic pastoralists and hunter gatherers to set against the distances involved in the arid zones of the southern Levant. For nomadic pastoralists there is information about the possibilities and necessities for the movement of sheep and goat herds. Before the advent of motorized transport these sheep and goat herders used donkeys as pack animals; this is the major contrast in the movement potential of these groups compared with caprine herders of the Late Neolithic. Lancaster and Lancaster (1991, 130) indicate the grazing range of sheep and goat herds as up to 8-10 km. per day from water sources. Herds can be moved distances of 40 km. between grazing without difficulty (Lancaster and Lancaster 1991, 130). Lancaster and Lancaster (1991, 130) suggest that they could be moved *in extremis* 80 km. in two days without watering, between the morning of the first day and evening of the second. Presumably individuals, carrying water, but unencumbered by baggage, could travel further. Groups encumbered to a greater or lesser extent, especially in the absence of large pack animals, might travel somewhat shorter distances.

The potentially extensive areas that hunter gatherers can traverse over several seasons, not to mention generations, has been intimated by Binford (1983, 110-112). Binford documents residential core areas, that is the area in which base camps are established, used over one year by a Nunamiut Eskimo group, as 5,400 km.^{2} from which they can exploit an area of 25,000 km.^{2}. In a setting perhaps more comparable to those we are discussing, Bushmen families can be demonstrated to cover territories of this order (Binford 1983, 110). In their lifetimes territories exploited by Nunamiut hunters can be greater, of the order of 300,000 km.^{2} (Binford 1983, 114-5). Surveying the annual circuits of a number of hunter gatherer groups from desert Bushmen to Hadza and equatorial Punam, Binford (1980) indicates they cover distances ranging from 120 to 600 km. The mean distances in the individual site relocations involved in these annual circuits varied from 10 to 27 km.

It is not expected that these indications of mobility are necessarily representative of the actual practices of the groups responsible for the archaeological evidence with which this study is concerned. Clearly the nature of the exploitation of the arid zones and the patterns of mobility involved depend upon the particular resource distributions and subsistence practices of the groups concerned (section 3.7). However, they do give some indication of the distances which hunter gatherers and nomadic pastoralists can potentially cover. When the distances such groups cover are set beside the distances involved in our arid setting (see above) it is clear that groups could have crossed over the gradients between arid and reliable dry farming zones easily and relatively rapidly (section 9.1). Furthermore the distances involved in traversing considerable portions of the arid zones, which fringe the southern Levant, are not great, particularly when set against the potential areas that a lifetime scale of movement of hunter gatherers can involve (Binford 1983, 114-115).

Section 3.4. Vegetation.

In the northern part of the arid zone under discussion, (in areas where precipitation is less than 100 mm. *per annum*, in the *ard es-sawwan*, the southern and eastern *harra*, Wudiyan and *hamada*)(fig. 3.1), vegetation tends to be concentrated in the wadi beds with a thin spread of intervening perennials, and a spring bloom of annuals. In the steppe *Artemisia* and chenopods are predominant. *Poa sinaiaca* dominates the grasses and occasionally dense stands of *Stipa* grasses can occur. In the Saharo-Sindian desert settings *Haloxylon persicum* and *Haloxylon salicornium* (chenopods) and *Artemisia* are characteristic. In the Azraq oasis setting vegetation is obviously much denser and more varied. To the north west of Azraq in the Wadi Butm there are stands of *Pistacia atlantica* (terebinth) producing edible fruits and there are dwarf bushes of *Prunus arabica* (Garrard *et al* 1988b, 314). Other edible species in these areas include the seeds of *Stipa*, and possibly some chenopods, *Astragulus* and other legumes as well as the roots and stems of *Erodium*, *Orobanche*, *Ferula*, *Scorzonera* and the bulbs of *Iris* and *Asphodelus* (Garrard *et al* 1988b, 314). Bedu gather *Prosopis farcta* (Arabic: *showk*) in the steppe in these areas. In the Azraq wetlands there are extensive stands of reeds, rushes, sedges, grasses and *Tamarix* as well as the surrounding, particularly dense, desert and steppe vegetation.

In the Negev and the Hisma the contrasts are also between Saharo-Sindian and Irano-Turanian vegetational communities. In the northern Negev, some of the central highland areas, and in the higher areas of the Hisma, the latter are characterized by *Artemisia herba-alba* (Munday 1976) as in the steppe further north. In the Negev highlands relatively dense stands of trees are found, including *Pistacia atlantica*, and the shrub *Rhamnus disperma*. The lower, drier areas, including the Arabah, are characterized by the Saharo-Sindian communities dominated by *Zygophyllum dumosum*. Wadi systems are occupied by *Retama raetam* and *Thymelaea hirsuta*.

In Sinai, despite the low mean precipitation, trees do occur in isolated environments. Mediterranean relicts, including *Juniperus phoenicea* and Irano-Turanian species such as *Pistacia atlantica*, occur 40 km. from the Mediterranean coast in the limestone hills of Maghara, Jebel Hallal and Yi'allaq, where there is only 100 mm. mean annual precipitation. *Tamarix* grows in some wadis, and the cooler mountains of southern Sinai, with slightly more precipitation than much of the rest of Sinai, support, in places, *Pistacia khinjuk*, *Ficus pseudosycomorus*, *Crataegus sinaicus* and shrubs like *Rhamnus disperma*. In north Sinai sandy soils support *Artemisia* and other shrubs.

In the *hamada* of central Sinai vegetation is more restricted to wadis where dwarf shrubs are common, *Artemisia herba-alba*, *Anabasis articulata* and *Salsola tetrandra* (these last chenopods). On the hills in northern Sinai *Zyophyllum dumosum* and *Artemisia herba-alba* are common (Rothenburg 1979, 80-81). Edible plants, consumed today by the Beduin include the leaves of *Malva parviflora*, *Malva nicaensis*, *Sisymbrium irio* and *erysimoides*, *Artiplex halimus* (chenopod) and *leucoclada* (cooked like spinach), tubers of *Erodium* and roots of *Scorzonera* (Rothenburg 1979, 82). Fruits of *Rhamnus disperma*, *Ficus pseudosycomorus*, *Crataegus sinaicus* and various capers can also be eaten (Rothenburg 1979, 82).

Section 3.5. Other resources.

As the variable topography and rainfall and resultant variegated vegetation indicate, resources are distributed in patchwork fashion over the arid zones and some of the key resources may be subject to considerable fluctuations on both short and long term bases.

Section 3.5.1. Water.

A key resource, directly as well as indirectly, for human occupation of these zones is water. Conservative estimates of human consumption in the arid zones are c. 4.2 litres of water a day (Helms 1981, 189), (more in the summer). Domestic sheep and goat should drink every day, although *in extremis* they could go without for several days (Lancaster and Lancaster 1981, 130). The high demands of human communities on water resources, and, later in the Neolithic that of their livestock as well (section 3.7.1), in an environment where the indirect source of water is so limited and variable, mean that the location of relatively regular and reliable sources inevitably determines the nature of the settlement pattern.

Water resources throughout the arid zones can be broken down into two types. 1) There are long term, reliable and relatively abundant sources which are not directly affected by the variability and strength of local precipitation. These are inevitably springs and very rare perennial streams or pools. That is because these are often fed by aquifers which have a relatively large drainage catchment. The classic examples in northern areas are Azraq and Burqu'. Others exist at Wisad further south on the eastern edge of the *harra* and Umeiri south of Azraq (Lancaster and Lancaster 1991, 128). Other such sources are found scattered throughout the arid zone, for example, in the wadis al-Dahal, al-Hassiya, al-Ghuweib and Fidan in the north east Arabah (MacDonald 1992, 16), and near the Late PPNB site of Mesad Mesal in the north west Arabah (Taute 1981). In the Hisma there may have been a range of seasonally active springs in the early Holocene (Jobling and Tangri 1992, 147). There are significant springs in the Wadi Rum, for example at Ain Abu Nekheileh. In the Negev springs occur in wadis, examples occur in the Avdat/Aqev area at Ein Mor, Ein Arkov, Ein Avdat and Ein Aqev (Munday 1976, 14-15). In Sinai major perennial sources are located at the mouth of the Wadi el-Arish in the north, and on the borders of the Negev at Qadesh Barnea, Nitzana and el-Quseima (Rothenburg 1979, 45). In central Sinai is the Wadi es-Sudr. On the west side of the southern mountains is the Feiran oasis and there are more sources in the wadis leading to St. Katherine's. On the Red Sea coast there are large oases at Dahab and Nuweiba (Rothenburg 1979, 48-9). Along the edge of the Gulf of Suez coastal areas are numerous springs.

2) The second major kind of water sources is by far the most numerous, but less predictable and allows the exploitation of much wider areas, particularly important once the grazing needs of herds are considered. These are the seasonal rain pools that gather in mud flats (*qa*, *khabra*) and stream beds (*ghadir*)(Lancaster and Lancaster 1991, 128).

In some areas in the south, in particular, rock pools or the wadi beds where high groundwater can be tapped by shallow excavation are important (Rothenburg 1979, 42-43). In these settings, depending on the nature of the rainfall, the exposure of the source to evaporation and the temperatures experienced, water can be available for a few days or up to several months (Lancaster and Lancaster 1991, 128, Rothenburg 1979, 43). In the most favourable settings it may, on occasion, last through the hot summer months until it is replenished in the autumn.

The Wadi el-Jilat provides one such setting. Its name in Arabic probably means the wadi of the pools. When it rains water gathers in the wadi bed and sits in deep depressions in the base of the gorge. These pools are fed by run off from the wadi sides, but also by seeps where water penetrates through quaternary deposits into the tertiary limestones and runs off the flint/chert beds into the gorge. The deepest pool in the gorge may have been enhanced in the recent past, but others are natural formations, as is at least part of this largest pool by which the site of J7 is located. The water in these settings can certainly last into the summer months and quite probably, before the Bedu started pumping it out in the very recent past, it may have lasted through the summer on occasion. A question of considerable interest, therefore, is whether the gorge was in existence by the Neolithic? We know it came into existence some time after the late Epipalaeolithic and was fully formed by the Late Roman period. There only evidence for its date of formation is circumstantial and relates to the distribution of the sites. This involves the manner in which the major PPNB and Late Neolithic sites, J7, J13, J26 and J25 with their sequences of occupations, cluster around the deepest part of the gorge with its pools, in contrast to the whole series of Epipalaeolithic sites which are distributed more widely in the wadi (fig. 3.4). This is very suggestive of the possibility that significant water sources were already available in that setting in the Neolithic, even if the gorge was not yet fully formed.

These various types of water sources underpin life in the arid zones. This most essential resource and the pattern of its occurrence must have had a significant impact on settlement systems. Any larger aggregations of population (and at later periods their herds and flocks) and any *relatively* longer term settlements in the steppe, within a mobile exploitation pattern, would have had to rely on these reliable and relatively prolific sources. However, given the relatively short distances involved it may be that such components of the settlement system could also have been located in moister areas.

Two significant conclusions concerning the nature of settlement in the arid zones follow. Longer term residential locations will be situated close to a suitable water source and shifts in such residential locations could potentially cover considerable distances, particularly if the arid zones were used in the summer and early autumn. Interspersed between such residential locations may be a range of more temporary camps and activity loci. Reliable sources underpin such movements, but, to allow exploitation of wider areas, knowledge of the location and prolificacy of the more variable water resources is a key (Lancaster and Lancaster 1991, 128). Mobility in settlement systems, such as those of many hunter gatherers, can be seen as allowing information gathering as well as subsistence procurement thus providing a series of alternative options (Binford 1983, 204-208). Mobility is clearly the key to the successful exploitation of the arid zones.

Local subsistence resources.

Those components of the natural vegetation of the arid zones suitable for human consumption have already been indicated.

Section 3.5.2. Fauna.

The fauna shows some variability. Gazelle form one of the dominant components of the fauna in most of the arid settings described. Several different species may have been present, however. In the *harra* and *ard es-sawwan* the goitered gazelle, *Gazella subguttorosa*, was present in considerable numbers in the recent past (Nelson 1973) and was also present in the late Pleistocene and probably early Holocene (Martin pers comm.). At Basta (fig. 3.5) on the edge of the Edomite highlands both the goitered gazelle and the mountain gazelle *Gazella gazella* are reported by Becker (Nissen *et al* 1991, 32). In Sinai the Dorcas gazelle, *Gazella dorcas*, is present today (Rothenburg 1979, 94). In the PPNB in Sinai the Dorcas gazelle has not been positively attested, but the mountain gazelle, *Gazella gazella*, no longer present in the area, was the species represented (Tchernov and Bar-Yosef 1982, 25; Dayan *et al* 1986, 113). Dorcas gazelle is present in the Negev today with the mountain gazelle, *Gazella gazella* (Munday 1976, 22), but the Dorcas gazelle is the species claimed for late Pleistocene-early Holocene sites (Tchernov 1976). However, with only limited diagnostic evidence from Nahal Divshon (e.g. no horn cores) this may be open to question.

Equids also appear to have been present throughout the areas in question, where diagnostic evidence is available these have been identified as the onager, *Equus hemionus* (Garrard *et al* 1988a, 47; Henry 1985, 76; Tchernov 1976; Bar-Yosef 1984, 153). However, these were never a numerous component of those Neolithic faunal assemblages in which they were represented. The African wild ass, *Equus africanus*, has now been reported from the southern region (Becker 1992).

The distribution of wild caprines (members of the tribe Caprini including in the Levant *Ovis orientalis* - wild sheep, *Capra ibex nubiana* - nubian ibex and *Capra aegagrus* - wild goat or bezoar) is more problematic. Wild goat and sheep are not present in the area today, but the ibex (at least until recently) is present in Sinai, the Negev and the south of Jordan. These three species of caprine are known to have inhabited areas of the Levant during the late Pleistocene and Holocene. *Capra aegagrus* and *Capra ibex nubiana* are both crag dwellers. The ranges of both may extend from fairly moist into very arid habitats (Harrison 1968; Roberts 1977; Schaller 1977; Uerpmann 1987; Clutton-Brock 1987). *Ovis orientalis* can inhabit both rugged and flatter terrain in steppic and sub-desert areas (Harrison 1968; Roberts 1977; Schaller 1977; Uerpmann 1987).

The present environment of the Azraq basin has been described in detail already (see above), but of particular relevance here is the broad division into two regions, the southern and western region of plains and gently rolling limestone and chalk hills surfaced with a flint reg, the *ard es-sawwan*, and the northern and eastern region of rough and locally craggy basalt *harra*. Clearly one cannot assume that one or other of these broad geological/topographic zones presented a similar set of circumstances to the other in terms of providing habitats for caprines. Nor may one assume that the same circumstances prevailed throughout the entire area of either of these geographical units. One has therefore to consider separately the evidence as to whether either area formed a habitat for wild caprines.

Late Pleistocene and early Holocene faunal remains have been obtained from a range of sites in each of these areas. In the limestone region, faunal samples from Kharaneh IV (Epipalaeolithic) (Muheisen 1988) have been analyzed by Garrard and Martin. Of 4,625 bones identified by Garrard and more than 2,000 bones identified by Martin, none are caprines (Baird *et al* 1992, 28). Faunal samples from the sites in Jilat have been analyzed by Garrard, Martin and Montague. Of 3,380 bones identified by Garrard and Montague from J6, J8, J9 and J10 (Upper Palaeolithic and Epipalaeolithic), only 1 caprine bone was found (from J8) (Garrard *et al* 1988a, 46-48). Of over 2,000 bones from J22

(Epipalaeolithic), Martin has identified at least 1 caprine bone. No caprines have been found among the thousands of bones thus far analyzed from the Early-Middle PPNB site of J7 (Martin pers comm.). There were no caprine bones from PPNB J32 (Baird *et al* 1992). Presumably this may be taken as relatively good evidence that caprines were not generally present in the wild in these areas of the *ard es-sawwan* in the periods before c. 6,500 b.c.

From the northern, better watered area of the *harra*, there is evidence of what are presumably wild caprines from the Natufian site of Khallat Anaza. Khallat Anaza is located 50 km. north of Azraq on the south eastern flanks of Jebel Druze. Of 29 animal bones recovered by A. Betts and identified by Garrard, 18 are caprine (Garrard 1985). Crucially, and unfortunately, we have little evidence from which we could conclude whether or not more southerly parts of the *harra* may have formed such a habitat. No Epipalaeolithic sites have been excavated in these latter areas. As evidence from the Jilat indicates that caprines were almost certainly being herded in the steppe from the earliest Late Neolithic it is difficult to use the evidence from Late Neolithic sites to resolve the question of whether these areas of the *harra* may have formed a habitat for wild caprines. Two PPNB occupation sites have been excavated in the *harra*. There are a very few caprine bones in the PPNB assemblage from Dhuweila (fig. 3.5)(studied by Garrard and Martin), (Martin pers comm.). At the PPNB site of Ibn el-Ghazzi (70 km. east of Azraq)(fig. 3.5), Garrard identified 2 caprines out of a total of 20 bones found (Garrard 1985). Given that the later PPNB is the crucial period during which caprines may have been first herded in the steppe and that we may be observing similar circumstances of caprine exploitation at Ibn el-Ghazzi, Dhuweila and Azraq 31, one can hardly use the evidence from these sites to resolve the issue.

The Azraq oasis and Wadi Uwaynid lie at the margins of the basalt region where it meets the limestone steppe/desert. Faunal samples from Uwaynid 14 and Uwaynid 18 (Epipalaeolithic) were analyzed by Garrard and Montague. Of 621 bones, 1 was caprine. At Azraq 17 (Epipalaeolithic) and Azraq 18 (Natufian), 285 bones were identified by Garrard and Montague of which none are caprine (Garrard *et al* 1988a, 46-48). Whilst, taken at face value, this evidence might suggest that, as in the limestone steppe to the south and west, wild caprines were virtually absent from the Azraq oasis during the Epipalaeolithic, we must bear in mind that the total sample size of assemblages representing the Epipalaeolithic is smaller than in the case of Jilat and Kharaneh and that vital earlier PPN assemblages are lacking. At Azraq 31 in the Late PPNB 2 caprine bones were recovered from a sample of 56 in uncontaminated contexts. Possibly contaminated contexts with larger samples have similar proportions of species present (Baird *et al* 1992, table 3). When we do not know the situation in the neighbouring basalt steppe, where slight fluctuations in any putative wild caprine population size and distribution might have an impact in terms of caprine occurrence in faunal assemblages deposited at Azraq, the status of the very small numbers of caprines in the Late PPNB at Azraq 31 must remain problematic until more evidence accrues. The evidence from Epipalaeolithic Azraq and Uwaynid, and PPNB Dhuweila and Azraq 31 tends to suggest that even if wild caprines were present in the area of the *harra* adjacent to Azraq they do not seem to have been present in substantial numbers.

Further south *aegagrus* and ibex ranges may have overlapped. They certainly did at Beidha (fig. 3.5) in the dry farming zone (Hecker 1975, 30) where the bezoar was not herded, at least according to Hecker (1975, 338). Ibex and goat are present at Nahal Hemar (fig. 3.5), although possibly introduced during the Neolithic by hyaenas (Bar-Yosef and Schick 1989, 187). Wild sheep were present in the Hisma (Henry 1985, 76) and the central Negev in the late Pleistocene (Butler *et al* 1977). In Sinai ibex was definitely present on one Late PPNB site, Ujrat el-Mehed (fig. 3.5)(Dayan *et al* 1986, 108-110), but goat has yet to be positively identified (Bar-Yosef 1981c, Tchernov and Bar-Yosef 1982, Bar-Yosef 1984). Given the impossibility of currently distinguishing between post-cranial elements of goat and ibex (Hecker 1975, 30; Tchernov and Bar-Yosef 1982, 23) one must be wary of placing too much stress on negative evidence, however, as the absence of wild or herded goat could be very difficult to demonstrate. At Wadi Tbeik (fig. 3.5), for example all identifiable *Capra* bones are post-cranial fragments.

Until recently hare, fox, wolf and hyaena have been widespread mammals and this was almost certainly the case in prehistory. Tortoise is common on Jilat Neolithic sites and was probably common in some areas of the steppe.

A variety of steppe and desert rodents and reptiles also typify these arid areas.

In favoured, isolated locales, or perhaps on the edge of the moist steppe areas *Bos primigenius* was found during the early Holocene. It is documented at the particularly lush and favoured setting at Azraq and at nearby Uwaynid in the Late Epipalaeolithic and early Holocene (Garrard *et al* 1988a, 46; Baird *et al* 1992, table 3). It also occurs as very low proportions of late Pleistocene and early Holocene faunal assemblages from diverse settings such as Jilat (J6 and J7, Garrard *et al*, 1988a, 46), the Negev: Nahal Divshon (fig. 3.5)(Tchernov 1976) and Nahal Hemar (Bar-Yosef and Schick 1985, 187) and Sinai: Wadi Tbeik and Ujrat el-Mehed (Tchernov and Bar-Yosef 1982; Bar-Yosef 1984, 153; Dayan *et al* 1986).

Section 3.6. Past climates.

Since this study is concerned with behaviour in the early Holocene, during which time the climate and thus environments may well have been different from today (and indeed changing over the several millennia of the Neolithic), the evidence from which we may infer past climates or indeed climate change must be examined. This is particularly important in a study of arid areas where resources are variable and potentially limited. The major question concerns the degree of aridity in those areas that are arid under present conditions. As we have indicated a key contrast is between those areas where dry farming can be carried out reliably and those where it cannot. A subsidiary, but important question, is thus to what extent did this boundary differ from that today in the periods under discussion.

Section 3.6.1. Palynological evidence.

Unfortunately the evidence is very limited and weak. Palynology has provided one of the most potent tools for the investigation of past environments in Europe, but the opportunities for suitable palynological study of Holocene settings in the Levant, particularly in the arid areas with which we are concerned, are very rare. The use of pollen from archaeological sites to reconstruct general vegetation in an area has been questioned, both because of the potential biases of the depositional setting and because of the ease with which intrusive material can contaminate such deposits, as well as taphonomic factors. However, occupation sites remain dominant among the few sources of Holocene pollen in the arid areas under discussion (Horowitz 1976 and Henry 1985). In the moister areas of the southern Levant the beds of fresh water lakes have provided cores. But these are few, not closely spaced and the sequences are relatively poorly dated (Van Zeist and Bottema 1982, 277). Further they have provided what has been interpreted as conflicting evidence of general environmental circumstances (Baruch and Bottema 1991). Since agriculture was established and spread during the periods under study, human impact on the vegetation in the prime agricultural areas, providing the settings from which the pollen sequences are derived, may have been considerable and of course cannot necessarily be distinguished from changes due to climatic factors. Such inhibited evidence of climate change in moister areas makes suspect the extrapolation from it of inferences about the situation in more arid areas.

For what they are worth the inferences from the palynological evidence are detailed below. There are four sets of cores from the southern Levant, three from lake Huleh at the north end of the Jordan valley, in an area where current precipitation is 400-500 mm. per annum and one from an old lake bed at Birket Ram in the Golan. The most recent core from Huleh has better stratigraphic resolution and more (but not enough) dates (Baruch and Bottema 1991). Unfortunately the published part of this most recent core only extends into the very beginning of the Holocene. In 1982 Van Zeist and Bottema interpreted the first two pollen cores from Huleh as indicating an environmentally induced decline in oak woodland in the early Holocene during the period with which we are concerned (8,000 b.c. - 5,400 b.c.) following more humid conditions in the Late Glacial. This may not have meant less precipitation as global temperatures were rising. However, they did not consider the possibility of woodland clearance for agriculture and settlement, nor is it clear whether possibly reduced humidity relative to the Late Glacial might mean more or less available moisture than today. The fluctuations in arboreal pollen in the Birket Ram core were more difficult to interpret given the general forest setting. The most recent core from the Huleh indicates high levels of arboreal pollen in the Late Glacial, somewhat lower levels in the late 9th M.b.c. and yet lower levels in the 8th M.b.c. (Baruch and Bottema 1991). There are therefore no dramatic differences between the cores. Baruch and Bottema (1991) offer a similar interpretation to that offered earlier by Van Zeist and Bottema (1982) without considering anthropogenic effects and with no consideration of the situation relative to that of today.

A vegetation indicative of moist steppe has been inferred from the pollen record of Nahal Divshon (Horowitz 1976) on the basis of the presence of species now found slightly further north, including 8% arboreal pollen and much *Compositae*. However, we have seen that even today the highlands of the central Negev provides a niche for trees (see above). From Henry's survey and excavation project in the Hisma there was only one Early PPNB site and no pollen was recovered from this occupation (Henry 1988). This evidence is very limited and, as already indicated, of problematic reliability.

Section 3.6.2. Deep sea cores and atmospheric circulation patterns.

Deep sea cores and interpretations of general developments in atmospheric circulation and precipitation regimes also have a role in climatic interpretation, of greater importance than we might like, given the poverty of the palynological record. The climatic regime that prevails in the southern Levant today is classically Mediterranean with its winter rainfall regime, even in Sinai. A major question raised by consideration of atmospheric circulation patterns is whether summer rainfall typical of more southerly areas, that does not currently affect the area of study, may have penetrated further north (Wigley and Farmer 1982), thereby bringing summer rainfall at least to Sinai. Some light may be cast on this by deep sea cores from the eastern Mediterranean, the Gulf of Suez and the Red Sea (Luz 1982). The major conclusion from Luz's work relevant to the Holocene is a period of increased humidity at the beginning of the Holocene in the areas around the Red Sea. In the Red Sea a reduction in salinity cannot be ascribed to increased fresh water due to the reduction in size of the northern ice cap as it can in the Mediterranean. It seems more likely that it was due to increased precipitation during the rise in global temperatures - also indicated in the deep sea cores. This precipitation could conceivably include summer precipitation in this southern area.

There are two other sources of evidence reflecting the character of the environment, particularly the local environment in the arid zones. These are both even more problematic of interpretation than the palynological evidence and the deep sea cores. They are the evidence of geomorphology and of the flora and fauna from the sites themselves.

Section 3.6.3. Geomorphology.

Problems with inferences from geomorphological features to the environmental circumstances that surrounded their formation relate to the very limited modern documentation of such formation processes in the sort of arid settings characterizing the southern Levant (Goldberg 1976, 51). Further, climatic and anthropogenic factors may be difficult to disentangle in the periods with which we are concerned. Classic cases are aeolian deposits and wadi terrace formations. For wind borne silts to become available there presumably has to be a certain amount of vegetation reduction. On the other hand for the silts to be trapped there presumably had to be a certain amount of vegetation present (Garrard *et al* n.d.). Similarly for terraces/aggradational units to form in wadis a certain set of hydrological conditions must exist that allow both transport and deposition; these circumstances are not common today. For example, Besançon *et al* (1989, 61) have suggested that wadi aggradation in the Azraq basin would have occurred during "catapluvial" phases i.e. transitions from moister to dryer conditions when vegetation loss freed sediments for transport but conditions were moist enough for low energy streams to deposit them. Traditionally wadi terrace formation in the arid zone might have been interpreted as indicating moister conditions *per se* (Goldberg 1976, 52; Copeland and Vita-Finzi 1978).

Ironically the geomorphological evidence relating to the late Pleistocene is better understood than that relating to the early Holocene. There is no geomorphological evidence of significance from the *harra*, or *hamad* to its east, relating to the early Holocene environment. Considerable work has now been done on the geomorphology of the Azraq basin, but little is of value in interpreting early Holocene environments. In Jilat and Wadi Uwaynid Epipalaeolithic sites have sealed, or been sealed in, sequences of sediments of considerable variety that allow chronologically well calibrated periods of varying sedimentation to studied (Garrard *et al* n.d.). One major conclusion of the study of these sequences is of a relatively moist period in the Late Glacial which corresponds well with the pollen evidence from Huleh (Baruch and Bottema 1991). Such sequences do not exist for the early Holocene. The Neolithic sites contain aeolian silts, but clearly much deposition on the sites relates to human activity.

The situation further south is similar - relatively valuable geomorphological sequences have been established for the late Pleistocene, but none in the Hisma, Negev, and Sinai (Henry 1985, 75-77, Goldberg 1976, Goldberg 1986, Marks 1977, 5-8 and Bar-Yosef and Phillips 1977) include the early Holocene. However, there are poorly dated, but probably Holocene, aggradational units in the Wadi el-Hasa. One set of these belongs to earlier in the Holocene and was formed in two phases, the later of which persisted until after 2,000 b.c. (Copeland and Vita-Finzi 1978, 23; Clark *et al* 1987, 69) and the earlier of which formed in the early or mid-Holocene. The original interpretation that these terraces represent moister episodes should now be re-evaluated and oscillations from moister to dryer regimes or circumstances of vegetation loss are suggested (Clark *et al* 1987).

The other evidence used for environmental reconstruction is that of the preferred habitats of species found in the faunal and floral assemblages from contemporary occupation sites. There are clearly limitations with this evidence. 1) We do not know the range over which the hunters and gatherers procured the species concerned. In particular this affects interpretation of the isolated occurrences of particular species in the record. One cannot help but wonder whether such occurrences represent rare encounters at considerable distances or occasional transport of such items as part of relatively long distance moves on the part of the groups concerned. 2) We cannot reconstruct in a very precise manner the habitat preferences of animals now extinct or without living relatives in the areas concerned. This affects in particular, *Bos primigenius*, *Equus hemionus*, *Capra aegagrus*, and *Ovis aries*.

Section 3.6.4. Fauna.

The use of fauna and flora for environmental reconstruction is particularly favoured by the Israeli school of thought, exemplified by Bar-Yosef (Bar-Yosef 1981, 1984, 1988). For example, Bar-Yosef has suggested that the early 8th M.b.c. was more moist than today, based on the evidence for moist settings suggested by components of the fauna in the Jordan valley from sites of this period (Bar-Yosef 1988). Thus Bar-Yosef argues that what today are small, shallow, marshy basins in the Salibiya-Fazael area were more extensive fresh water ponds; he uses the presence of a large number and the high frequency of water fowl species and the presence of the water vole as indicators. The local hydrology has presumably been affected considerably by man's activities in the recent past and therefore differences in the nature of ponds in what are today still marshy settings may not necessarily directly reflect climatic factors. The same problematic affects all interpretations of evidence for moister conditions in the Jordan valley in the early Holocene. There may well have been more water in specific locales than today, but does it necessarily indicate higher precipitation or humidity - essential if such 'conditions' are to be extrapolated to the arid zones.

In the arid zones there is such evidence, but it is also problematic. In the Negev at Nahal Divshon, a 7th M.b.c. PPNB site, there is Mesopotamian fallow deer and *Bos primigenius*. These are individual occurrences, however (Tchernov 1976, 69). The former certainly preferred woodland areas, but the latter could also probably flourish in open scrub (Clutton-Brock 1987, 63).

From Sinai, at Wadi Tbeik and Ujrat el-Mehed in the Late PPNB (Bar-Yosef 1984, 153; Dayan *et al* 1986) and Jilat, J6 and J7 (Garrard *et al* 1988a, table 4) and J13 (Louise Martin pers comm.) there are further sporadic occurrences of *Bos*. These may represent no more than the remains of single individual in each case. Bar-Yosef has again suggested wetter conditions in Sinai on this basis (Bar-Yosef 1984, 153). However, it is quite possible that *Bos primigenius* was tolerant of a wider range of conditions than many have so far admitted (Clutton-Brock 1987, 63). In all these cases we are dealing with very isolated and therefore problematic occurrences.

More significant may be the occurrence of rather specifically adapted species like the Nilotic catfish and Purple gallinule which occur at Wadi Tbeik (Bar-Yosef 1984, 153). The latter is a sedentary bird, which requires stands of still, open water and today is only found in the Nile. Both these species suggest that there was perennial, standing water in southern Sinai at this period - or that items were brought in from Eygpt! In the late Pleistocene there was standing fresh water in the Wadi Feiran (Phillips 1988, 184) and rich oasis settings might still have been present; this, however, may well suggest somewhat moister conditions. These may also be implied by the deep sea cores (Luz 1982). It should be noted, however, that in Sinai, and in the limited evidence from the Negev, the faunas are dominated by steppe species, gazelle, ibex and some equids.

In north east Jordan, except in the lush setting of Azraq, the early Holocene wild faunas are also dominated by steppe species, principally gazelle, with some equid. The absence of wild caprines, which require water each day, over an extended period from c. 19,000 b.c. - 6,500 b.c. from sites in Jilat, and Kharaneh to the north, may also point to steppe conditions (see below). What may be particularly significant in this regard is the fact that much the same fauna is present from the late Epipalaeolithic to the PPNB and as we have seen the Late Glacial period probably saw greater available moisture than the early Holocene.

Section 3.6.5. Floras.

Unfortunately no carbonised plant remains have been recovered from the Neolithic sites in Sinai, but they have been recovered from one site in the Negev; in the Sinai flotation was a considerable problem due to the limited availability of water (Bar-Yosef 1984, 148). At Nahal Hemar (fig. 3.5) domestic barley, emmer and lentils, along with weeds of cultivation were recovered (Bar-Yosef and Schick 1989, 187). Cereals cannot grow in the area today and the closest locales for cultivation are c. 15 km. to the north.

A number of sites in the Azraq basin have, however, produced significant amounts of carbonised plant remains being studied by Susan Colledge. Thus from Early and Middle PPNB J7 plant remains from non-cultivated species include many examples of steppe/desert species common in these arid areas today (Garrard *et al* 1988a, 45). These include chenopods, *Compositae*, certain legumes such as *Astragulus* and *Trifolium* and other species, including *Erodium*, the tubers of which we know are eaten by the Beduin (Rothenburg 1979, 82). Various parts of some of these chenopods could have been eaten, as could some of the legume seeds. Also present were fragments of shells from nuts from *Pistacia* trees, almost certainly gathered for consumption, possibly at some distance. Whilst most of the species represented are found in the area today, indicating that the climate cannot have been dramatically different, they do have a wide tolerance and distribution range, also occurring in moister areas further to the west (Colledge pers comm.).

High proportions of the charred plant remains from J7, J13 and J25 are from cultivated cereals, including barley at all three sites and einkorn and a free threshing wheat at J7 (Colledge pers comm., Garrard *et al* 1988a, 45). In addition wild barley, *Hordeum spontaneum*, occurs at J7, although it may, of course, have been cultivated, or been a weed of cultivation. Also present at J7 were lentils and pea. None of these crops can be grown in the area today without irrigation. The closest regular cultivation occurs in settlements such as Hammam c. 35-40 km. to the west of Jilat, that is in an area with mean annual precipitation of c. 200 mm. or just less. However, barley is also grown in wadi beds only c. 20 km. away on an opportunistic basis. Often these poor crops are not harvested but grazed *in situ* by the local communities' sheep and goats. Such opportunistic cultivation has been observed in other steppe areas in the Azraq basin and outwith (Lancaster and Lancaster 1991, 136). Betts has referred to such opportunistic cultivation on the mud flats in the steppe near Wadi Ruweishid (Betts *et al* 1990, 4) as has Helms (1981, 184-185) in moist steppe settings near the Wadi Rajil slightly further north. Cereals have been recovered also from Dhuweila (Colledge pers comm.).

The presence of cultivated crops on these arid zone sites beyond the area where they are cultivated today may indicate 1) moister settings in proximity to the sites, 2) irrigation of crops close to the sites, or 3) the carriage of harvested cereals from areas to the west and north.

Section 3.6.6. Summary of evidence pertaining to environmental reconstruction.

The sum total of the evidence as to the actual nature of environmental change in the periods under study is negligible. The evidence of indigenous fauna from the arid zone sites and, in the north, the additional evidence of the floras, is that conditions were *not dramatically* different from those today, although there are hints that moist steppe zones might have extended somewhat further east and south. The evidence for this is *very tenuous*, however. It is certainly too tenuous to deploy in any arguments about changes in human settlement patterns in these arid areas.

The evidence of pollen from the Huleh lake suggests that the early Holocene was not as moist as the Late Glacial, further evidence that the climate was probably not dramatically different in the early Holocene from that now prevailing. Deep sea cores suggest more favourable, moister conditions may have pertained in southern areas in the early Holocene; this was perhaps because of the penetration of summer rainfall further north than today.

Whilst the dry farming zone may have been somewhat more extensive in the early Holocene, much of the area today defined as arid zone would still have been relatively arid, even should better conditions have prevailed. Under any such optimal conditions, while the unpredictability and variability of resources that characterize the zone today may well have been somewhat reduced. However, they would still have been the most characteristic feature of these areas. Further the key inhibiting factor in human land use in these areas is not likely to have been dramatically different, that is the location and scale of reliable and prolific water sources.

Section 3.7. Subsistence practices.

Some indication of subsistence practices in the arid zone has already been provided in a discussion of the environments of the sites.

Section 3.7.1. Animal exploitation; hunting and herding.

In the Azraq basin only the hunting of local species can be clearly attested before c. 6,500 b.c. (Baird *et al* 1992, 28-9; Garrard *et al* n.d.). In J7 Phase I (section 4.4.1) gazelle are the predominant species (Louise Martin pers comm.). In J7 Phases II and III (section 4.4.1) hare becomes more important as a proportion of identifiable bones, but gazelle were still undoubtedly important in terms of meat yield (Louise Martin pers comm.). Hare dominates at J32 (Baird *et al* 1992, 26). Only a very small number of identifiable bones exist from extensive excavations at J26 (poor preservation conditions may be a factor). Gazelle and hare were exploited. Clearly locally available species were variably represented in these different occupations. This may reflect different behaviour on the part of the hunters, but also variation in the availability of the different species relating to seasonal or other factors (Bar-Yosef 1984, 158).

From the early 6th M.b.c. onwards caprines are present in relatively high proportions in both Jilat and Azraq. At J25, J13 Phases I and II, and Azraq 31 in the Early Late Neolithic (sections 4.4.4-4.4.6) caprines represent over 40% of the identifiable bones (Louise Martin pers comm.); at all four occupations goat is attested and at J25 and J13 the samples also include sheep. Given the Epipalaeolithic and earlier Neolithic faunas of the areas (see above) the presence of caprines in such numbers can be taken as an indication of the presence of herded animals.

The situation in this part of the steppe in the Late PPNB is obscure. Low proportions of caprines occur at Azraq 31, Dhuweila stage 1 and Ibn el-Ghazzi (Baird *et al* 1992, see above). The first two sites are definitely, the third possibly, Late PPNB. The question of the presence of wild caprines in the southern area of the *harra* cannot currently fully be addressed. The presence of low proportions of caprines at these Late PPNB sites could result from hunting or herding. If herded caprines were present it is pertinent to ask why there should be so few represented on sites of these periods. Herd management practices or the underlying motivation in early pastoralism may have resulted in low rates of culling. If animals were kept for secondary products (hair and milk) or as an insurance against the failure or unpredictability of other resources - and the latter may be key in the steppe/desert settings under discussion - it would be logical that only low numbers of animals might be culled. Alternatively culling might have been restricted to certain seasons not represented by occupations that we have documented, or plausibly not represented by any occupation in the steppe. On the other hand the earliest herders in the steppe may have had very few animals. Whatever the low proportions of caprines represent at Azraq 31 and Dhuweila at the end of the 7th M.b.c., whether hunted or herded animals, subsistence practices had clearly changed by the early 6th M.b.c with a substantial rise in the proportions of caprines culled in these areas.

Gazelle dominate the Late PPNB Dhuweila stage 1 faunal assemblage (Martin pers comm.) and are important at Late PPNB Azraq 31 (Baird *et al* 1992, table 3). At Azraq 31 *Bos* and *Equus* are also important, particularly in terms of a meat contribution to the diet (because of their greater body weight). The importance of *Bos* and *Equus* at Azraq 31 clearly indicates a hunting regime responsive to local conditions.

Hunting remained important during the 6th M.b.c. despite the apparent ubiquity of herding. Alongside the caprines at J25, and J13, gazelle and hare remain important and at Azraq 31 there is *Equus* and *Bos*. In the Early Phase on J13 in Area C, for example, gazelle form c. 33% of the assemblage (Martin pers comm.), which seems to be representative of the site as a whole. Definitely hunted species continue to be of considerable importance at 6th M.b.c. sites in the *harra*, mostly gazelle and hare, but also some equids. Dhuweila stage 2 (Betts 1988a, 13), Jebel Naja (Garrard 1985), Burqu' 27 (McCartney 1992, 50-1) and other Late Neolithic sites at Burqu' (Betts *et al* 1991, 19) including 03 (Betts *et al* 1990, 11) all provide examples of this.

Of other parts of the arid zone only Sinai provides a possible indication of subsistence strategies in terms of the question of the appearance of pastoralism. Only hunted animals appear to be present at Ujrat el-Mehed (Dayan *et al* 1986, 108) and this is claimed to be the case at Wadi Tbeik (Tchernov and Bar-Yosef 1982). Both of these are Late PPNB sites of the second half of the 7th M.b.c (section 4.3.3). At both these sites ibex were probably the predominant prey, but gazelle were also important, and some equids were hunted as well (Tchernov and Bar-Yosef 1982; Dayan *et al* 1986). In short there is no clear evidence of the introduction of herded caprines before 6,000 b.c. (Bar-Yosef 1984). On the other hand we cannot, at this stage, completely rule out the introduction of herded goat before 6,000 b.c. because of the difficulties of distinguishing ibex and goat on post-cranial elements (Hecker 1975, 30). Since at Wadi Tbeik (Tchernov and Bar-Yosef 1982, 23) *Capra* is only represented by post-cranial elements there is always the possibility that herded goats are represented. Since occupations of the 6th M.b.c. have not been successfully isolated in excavation in Sinai the question of the precise period of appearance of pastoralism remains problematic other than that it must occur at, or later than, the very end of the 7th. M.b.c.

At other sites in the arid areas gazelle are important, Nahal Divshon (Tchernov 1976), Nahal Hemar (Bar-Yosef and Schick 1989, 187) and some caprines occur. At Nahal Issaron (Goring-Morris and Gopher 1983) caprines were important. It is unclear at these sites which species of caprine is present and whether the caprines were domesticated.

The evidence of Sinai and the Azraq basin is thus in relative accord. There is no conclusive evidence of herding on a significant scale before the earliest Late Neolithic; how does this evidence compare with that for the moister areas? It is difficult to compare the evidence for the appearance of herded caprines in the arid zones with that for herding in the moister areas because wild caprines were present in these latter areas in the Epipalaeolithic and conclusive evidence of early domestication is still a subject of debate (Hecker 1975; Köhler-Rollefson 1989; Becker 1992, 63-66; Ducos 1992).

For example, Clutton-Brock is equivocal about the status of the goats at Jericho (Clutton-Brock 1983 and 1987). She ascribes significance to a considerable contrast in the proportions of caprines at Middle PPNB Jericho, where they are very important, compared to PPNA Jericho (Clutton-Brock 1983, 802; Clutton-Brock 1987, 60). 2 out of 35 goat horn cores in Middle PPNB levels were twisted. This characteristic is normally taken as an indication of domestication. These are, however, a low proportion of the Middle PPNB sample of goat horn cores (Clutton-Brock 1987, 60-1). One wonders whether these 2 horn cores may have been intrusive from overlying PNA or Bronze Age deposits. Clutton-Brock admits (1983, 802) that morphologically the goat bones are indistinguishable from those of the bezoar and that the probability is that they represent hunted animals. After extensive analysis Hecker (1975) concludes that the caprines at Middle (and possibly Late PPNB) Beidha represent wild animals, but that cull patterns indicate a very specialised predatory relationship between man and caprines, involving herd manipulation. The difficulty of distinguishing between ibex and bezoar, both present at Beidha, on the post-cranial bones, however, renders suspect judgement on man-caprine relationships when the cull patterning detected relates to the caprine population as an undivided whole. At Ain Ghazal Köhler-Rollefson (*et al* 1988, 425) has concluded that the goats of the Middle and Late PPNB represent animals that are morphologically similar to wild specimens, but that ages/sex ratio and a relatively high frequency of pathological conditions (that would not normally persist with such frequency in a wild population subject to predation from a range of other wild animals), must indicate a 'special relationship' between man and goat involving some sort of herd management (Köhler-Rollefson *et al* 1988, 425; Köhler-Rollefson 1989, 145). Wild sheep and goats form sex-differentiated bands throughout most of the year (Hesse 1984, 251). The full cross-section of a population is not necessarily present in one setting for much of the time. Caution must be exercised, therefore, in interpreting the predominance of certain age and gender classes in samples of caprine bones as necessarily indicative of selective and specialised management. It can be envisaged that man's effect on his environment in the vicinity of his large permanent settlements in the 7th M.b.c. was considerable; the degree to which the goats' predators continued to operate in those areas may be questioned. Köhler-Rollefson claims that domesticated caprines are present from the PPNC onwards at Ain Ghazal (Köhler-Rollefson *et al* 1988, 426). This claim is based on the size of the caprines. In further work she points out that the reduced size of adult caprines probably relates to the lack of males in the sample; she ascribes this to herd management typical of domestic herds in the area today and in the recent past (Köhler-Rollefson 1989). As we have seen caution must be exercised in identifying domestication on the basis of the presence of disproportionate numbers of one gender/age class. Horwitz is convinced that domestic caprines were absent from northern Palestine in the PPNB on the basis of her work at Middle and Late PPNB sites there, such as Yiftahel, Kfar Hahoresh, Nahal Betzet, Horvat Galil, and Atlit (Horwitz 1987; 1989, 169). The evidence of Ducos is similar; at Middle PPNB Munhata the caprine population is indistinguishable from ones found in the wild (Ducos 1969, 273). At Basta Cornelia Becker (1992) is convinced of the presence of domestic caprines in considerable numbers on morphological grounds - size reduction in both sexes - from the Late PPNB

(Nissen *et al* 1991, 32). This is the earliest convincing evidence of domestication of caprines in the southern Levant.

On this basis the herding of caprines may have begun in the moister areas of the southern Levant only very shortly, if at all, before they appear in those steppe/desert areas outside their natural range. It is assumed that, since the bones of herded caprines are so abundant on the sites of the Early Late Neolithic of the Azraq basin, the communities occupying those sites were the herders of the animals represented, rather than that they obtained caprine carcasses from other groups. The equivalent assumption is not made in relation to cultivated vegetal resources, but clearly these are easier to store, conserve and transport once harvested.

Section 3.7.2. Plant remains; gathering and farming.

Gathering of wild vegetal resources by communities exploiting the steppe for subsistence purposes can only be demonstrated in relation to *Pistacia* nuts on Jilat sites of the PPNB and Early Late Neolithic (Susan Colledge pers comm.). Carbonized tuber and root tissues are also present on J7, J13 and J25 and it seems likely that they too would have been gathered from the local environment (section 3.1.4) (Susan Colledge pers comm.). The presence of carbonised components of *Orobanche*, *Erodium*, *Astragulus*, *Malva*, *Artiplex*, and *Stipa* on sites like J7 and Dhuweila (Colledge pers comm.), all of which include species that were edible, may well suggest that gathering played some role in subsistence activities.

As has been indicated above cultivated cereals and legumes are present on both the PPNB and Late Neolithic sites in Jilat and Azraq (Garrard *et al* n.d.) as well as further east at Dhuweila and in the south at Nahal Hemar. Whilst cultivation, possibly with the aid of irrigation, might be relatively easily conceived on the margins of the Azraq wetlands, its practice in Jilat is a different question. Three alternative explanations for the presence of cultigens outside the current reliable dry farming areas have been offered (section 3.6.5). In terms of subsistence practices these can be reduced to two essential alternatives. 1) They are the result of the practice of agriculture - opportunistic or not - by components of these undoubtedly mobile communities, whether because of irrigation or more favourable conditions, in or close to these sites or without necessarily the aid of irrigation or more favourable conditions closer to the modern dry farming zone. 2) They represent the acquisition of several of the products of cultivation on a consistent basis from other communities in the dry farming zone. Whether or not the mobile communities of the arid zone were farmers, over considerable periods of time their subsistence needs were provided for, at least partly, by the products of an agricultural system.

The socio-economic environment in which these Neolithic communities operated in the arid zone was one of hunting-gathering-farming, to which was added herding, in later periods. It is therefore not appropriate to consider these groups as hunter-gatherers, or as herders, or as farmers whose social organization and behaviour was framed by a particular discrete subsistence base. These communities practised a number of options, amongst which, potentially, emphasis could easily and effectively shift, presumably as required. Lancaster and Lancaster (1991, 136) also emphasize the implicit flexibility of those that exploited the arid zone. The implications of these factors will be fully considered in the final discussion of evidence for the broader behaviour, and developments in behaviour, of arid zone communities in the Neolithic in the light of the themes outlined in the introduction.

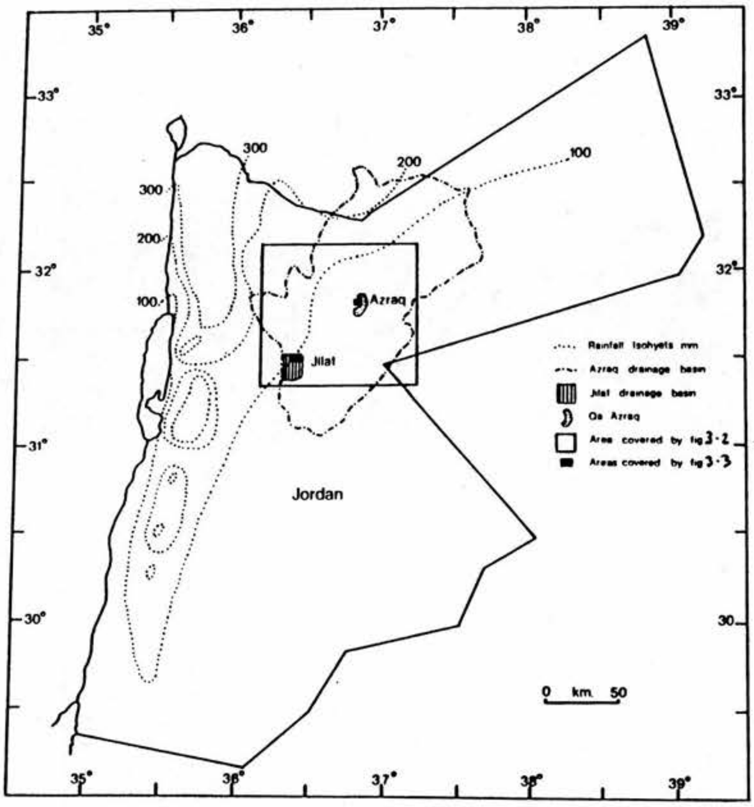


Fig. 3.1 Map of southern Levant indicating the Azraq basin and isohyets.

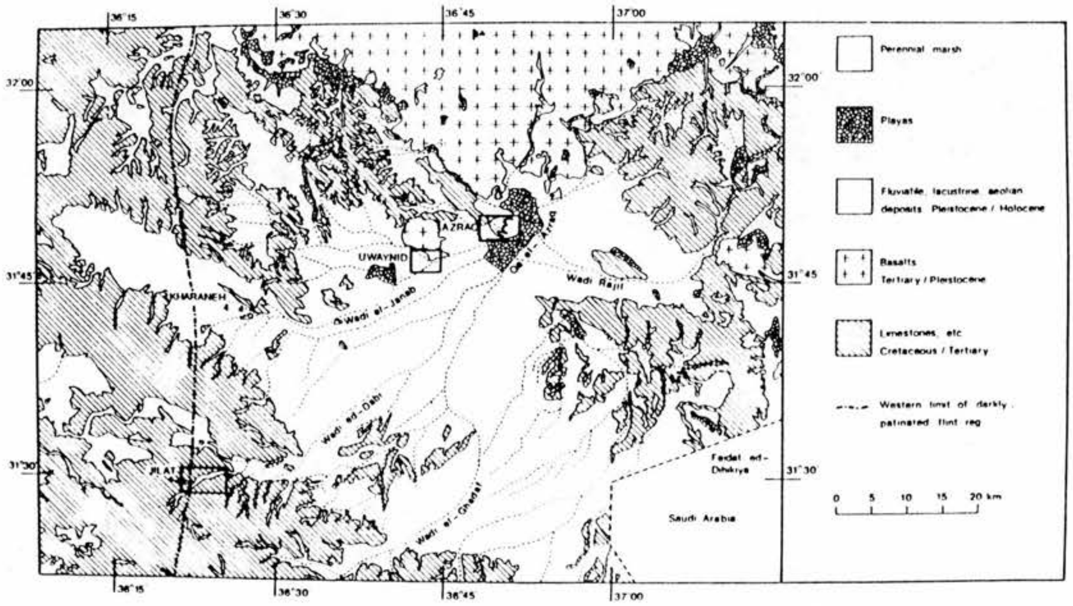


Fig. 3.2 Map of the Azraq basin indicating the Wadi el-Jilat and Azraq wetlands.

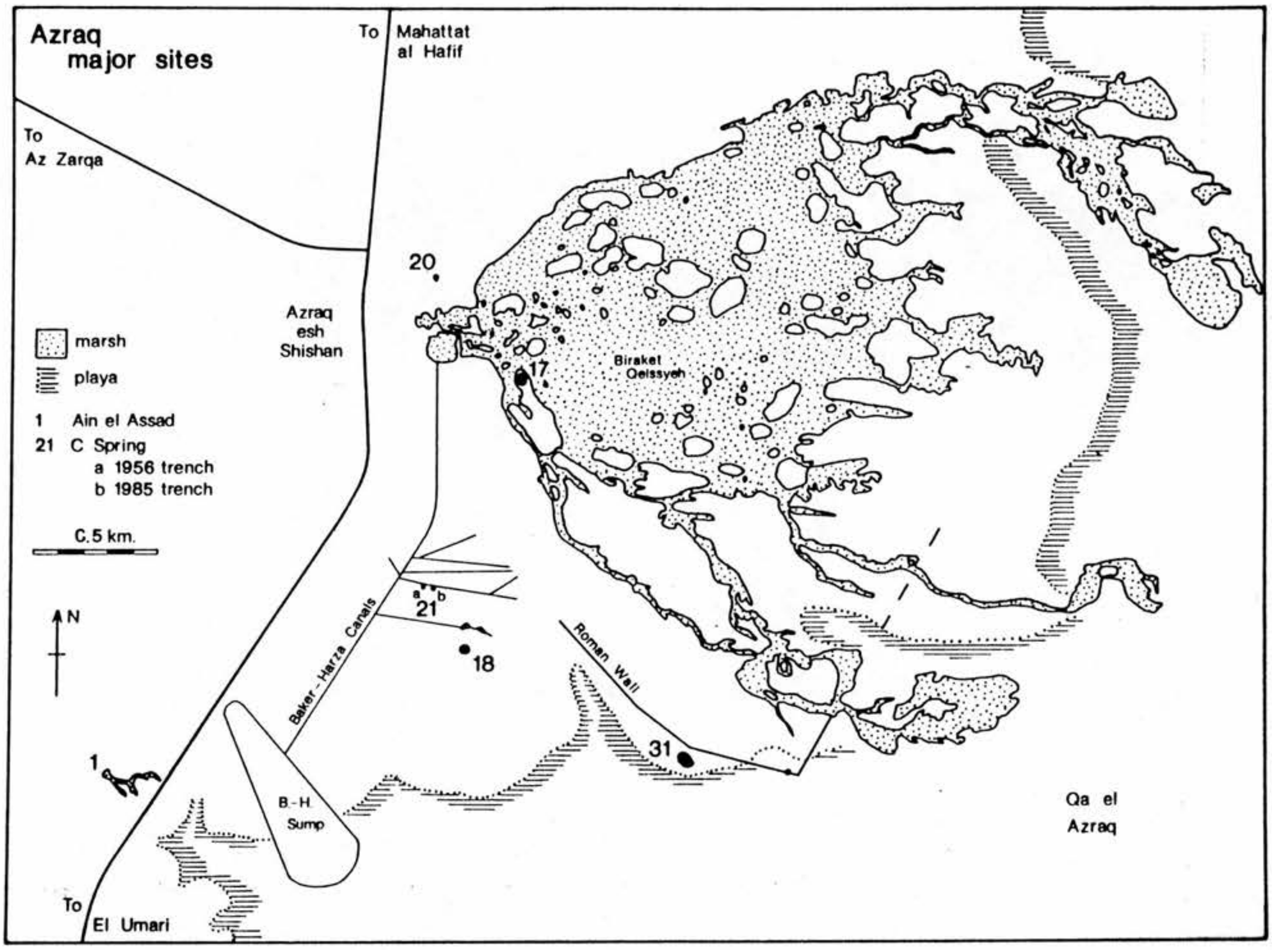


Fig. 3.3 Azraq Project sites around the Azraq wetlands.

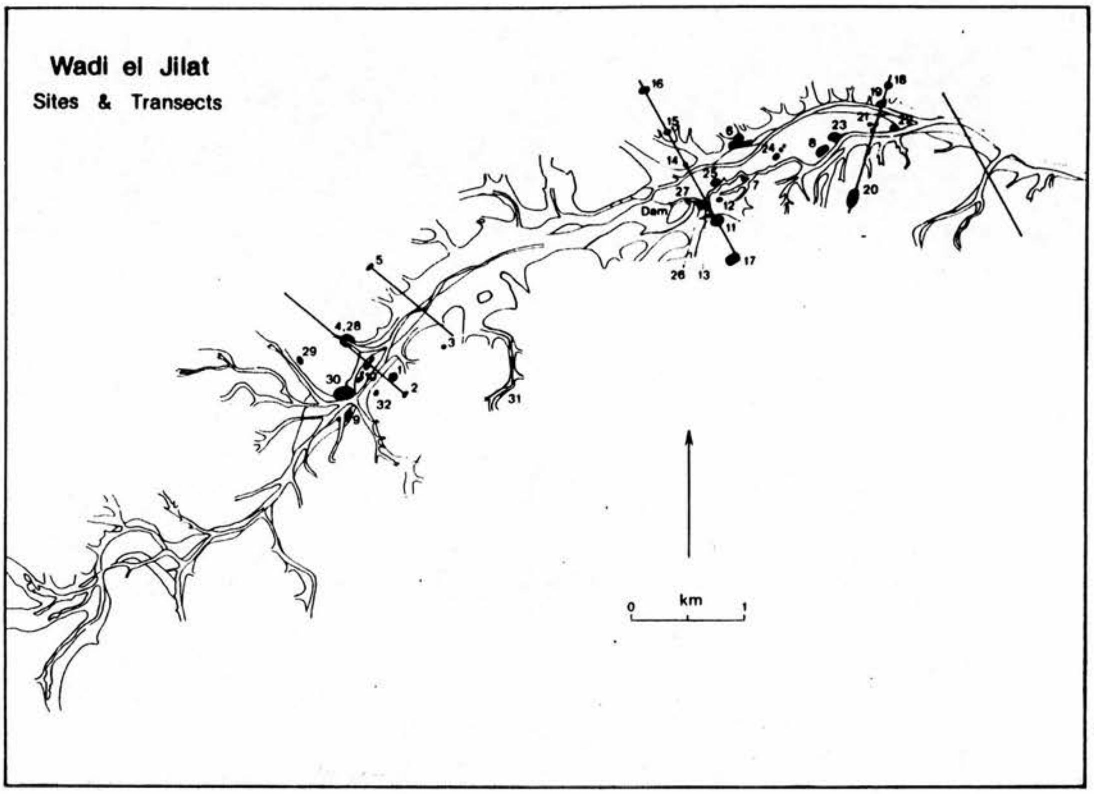


Fig. 3.4 Wadi el-Jilat location of sites.

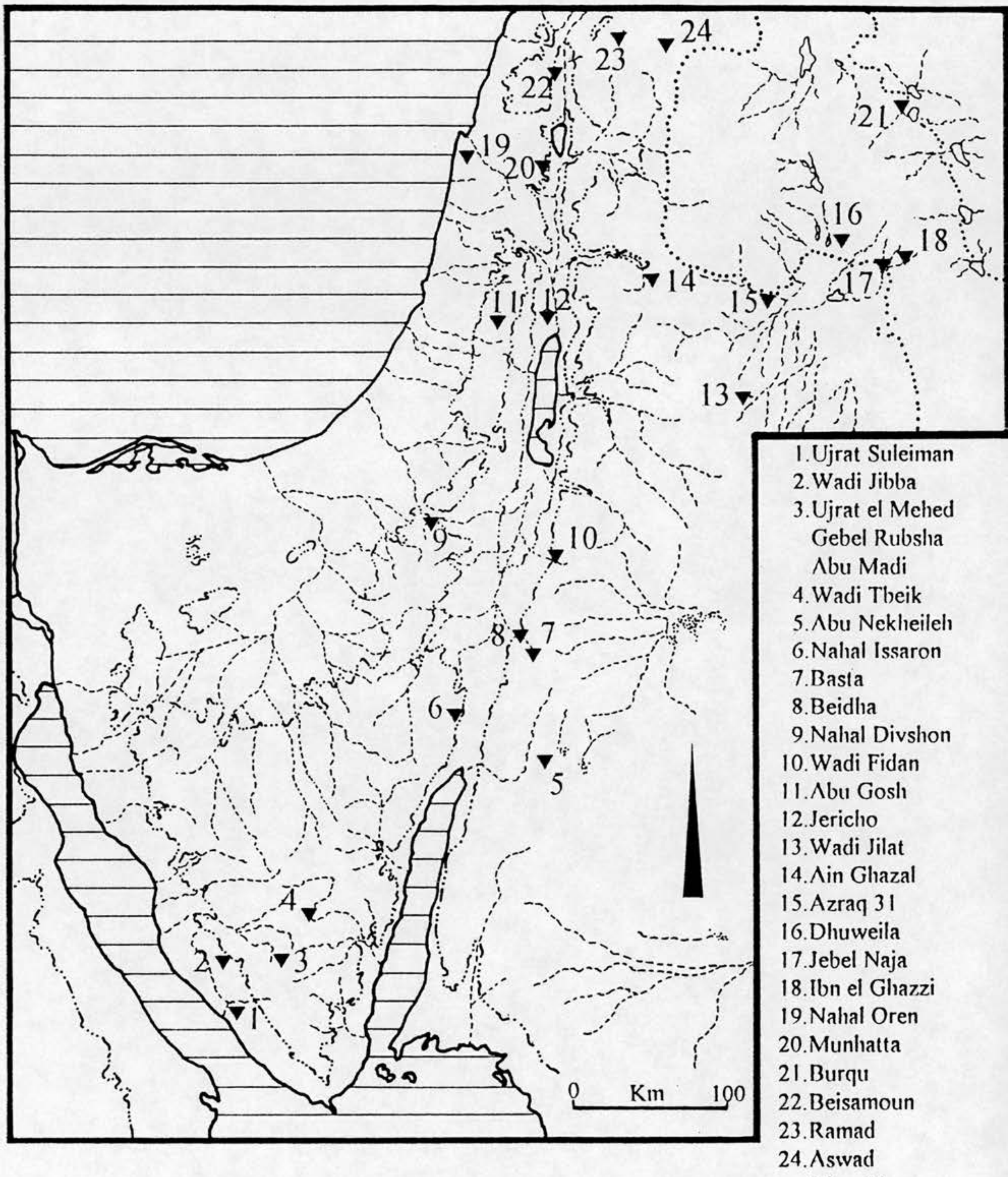


Fig. 3.5 Excavated arid zone sites in the South Levant and other key sites mentioned in the text.

SECTION 4.

A CHRONOLOGY OF LEVANTINE NEOLITHIC SITES AND THE PLACE WITHIN, AND SIGNIFICANCE FOR, SUCH A CHRONOLOGY OF THE AZRAQ BASIN NEOLITHIC SITES.

Section 4.1. Introduction.

A chronological framework for sites and assemblages is essential to make effective any comparative study of material culture and to develop and compare inferences concerning prehistoric behaviour patterns. Some assessment of the degree of chronological resolution involved in that framework is also important. Since the purpose of this research is to investigate the significance of the Azraq basin Neolithic sites in relation to each other, to other sites in the arid zones and to sites in more moist areas, the intention of this section is to investigate and establish the most firmly founded version of such a chronological framework possible. The Azraq basin sites will be placed in that framework and where they can add to that framework this will be indicated.

As a variety of evidence indicates (sections 3.5.1 and 9.1.2.1 and 9.2.1), the spans of time involved in the occupation of sites in Wadi el-Jilat and even the Azraq wetlands itself were relatively brief in comparison to the lengthy, continuous occupations of sedentary communities in moister areas. This does not deny that sites in the arid zone may have been frequently reoccupied. Paradoxically, the level of comparative chronological resolution we are dealing with, in the case of sites with even a series of relatively short occupation episodes, is less precise than those instances when occupations on sites are likely to have been of such extended duration as to match the imprecision of the chronological framework. Clearly such statements already depend upon inferences about settlement patterns. At stake here, however, is not the issue of the construction of the chronological framework, but the use of that framework. Thus it becomes impossible to talk of contemporaneity of sites with episodic occupations in any meaningfully precise sense. To indicate a degree of imprecision involved in discussing sites that belong to the same broad divisions of the chronological framework I will use the term coeval. For sites with lengthy occupation periods it may well be possible to talk about broad contemporaneity - between them and other sites with long occupations - and even between them and sites with episodic occupations. As will be seen from the chronological framework constructed below (section 4.3), it is only possible to talk in terms of chronological units of the order of half a millennium of uncalibrated radiocarbon years. It may be possible, in some cases, to provide C14 dates for sites that describe shorter time units (when double standard deviations, inter-laboratory variability and other factors are taken into account). Such cases are not yet frequent enough to make them useful in broad comparative studies. It will probably remain the case that relative precision can only be obtained within chronological frameworks, in the case of very detailed local sequences of occupations by sedentary communities.

To begin with it seems appropriate to outline a seriation and the basic pillars which support this (we hope not too shaky) edifice. A seriation will be effected based upon stratified sequences; when combined with C14 dated assemblages a periodization can be constructed where certain types of assemblages can be suggested to cover specific, albeit, imprecise time spans.

Section 4.2. Point sequences.

The principal relative chronological tool, upon which chronological sequences of pre-pottery Neolithic sites have been built up in the Levant, is the developments in the morphology of projectile points, in conjunction with one or two other specific tool types, notably sickles. The sequence of projectile point types has been derived from a few, deeply stratified sites and amplified by a sequence of shorter occupations well-dated by C14. It has also been suggested that certain features of the technology may provide a rough guide to period. Thus opposed platform reduction producing naviform cores is supposed to characterise the PPNB as opposed to PPNA or most of the Late Neolithic (sections 6.9, 6.10 and 7.1.4). In Jordan, recently, researchers, notably at Ain Ghazal (Rollefson 1990, 122) and Basta (Nissen *et al* 1987, 97-98) have used changes in the proportion of flakes to blades to mark off developments from the late PPNB into the Late Neolithic or even a newly proposed period the PPNC. There are problems with this approach and this issue will be discussed further in a section outlining the technology of the chipped stone assemblages from the Azraq basin sites (sections 6.9, 6.10 and 7.1.4).

Section 4.2.1. Point descriptions.

It seems apposite, therefore, to first offer definitions of the key projectile point types, as they have been referred to in the literature. Where any room for doubt exists, I have used a definition that I have found preferable.

1) The Khiam point (fig. 4.1:3 and 7). This type has a transverse or concave truncation at its base, sometimes formed with Couze retouch (Brézillon 1983, 358) and, usually, a single pair of opposed notches most often relatively close to its base. Examples without notches also occur but these are rare. This is the classic definition used by M. C. Cauvin at Mureybet, for example (M. C. Cauvin 1978, 12). Occasionally pieces clearly related to Khiam points have rudimentary tangs as at Jericho (Crowfoot Payne 1983, 648, fig. 273:8); these last variants are thus morphologically similar to Helwan points. At Nahal Oren, Tamar Yizraely refers to Khiam points with truncated bases but with two sets of

notches (Stekelis and Yizraely 1963). One such was found at Jericho, but in PPNB levels (Crowfoot Payne 1983, 678, fig. 305:4). Where there are hints of the term being used to refer to other than the classic morphologies it will be pointed out and the significance of such variation in relation to possible confusions between types will be pointed out. In my analyses only classic types are described as Khiam points.

2) The Jordan valley point. Small point types with rudimentary or small, fine tangs, occurring alongside and related to Khiam points have, on occasion, been grouped with them (Crowfoot Payne 1983, 648, fig. 273:8). Enough information has now accrued to indicate that there is a separate group of small fine points with small fine tangs which occur alongside Khiam points in PPNA assemblages in the southern Levant (Nadel *et al* 1991). In effect, of course, by all essential definitional criteria, these are merely diminutive Byblos points (see below).

4) The Salibiya point. These points are, in effect, Khiam points without notches and until now have been grouped with Khiam points (Nadel *et al* 1991).

5) The Helwan point (fig. 4.1:1, 2, 4, 5, 6 and 8). This point type is defined by the presence of a distinct tang and notches (often multiple pairs) on its body. The tang is often formed by two notches at the base of the point, very similar to those on the body of the point, this tended to produce small tangs with distinct wings on the shoulders of the point. Some points have slightly larger tangs and rounded shoulders, however (Bar-Yosef 1981, 559-560, fig. 2:E). In some assemblages, dominated by Helwan points, there are occasional examples without notches. Typologically these are often Jericho points, which, at least in some forms, could be described as a Helwan point without notches. This may, indeed, indicate how this latter point form evolved. I have not classified these sporadic occurrences as Helwan points, but indicated the probable relationship where it

occurs (section 4.4.1). Helwan points have at least one pair of notches on the body, often several pairs, some of which may be located close to the tip, even as a single pair; this is rare on Khiam points. Obviously in its simplest small form and when of small size, there is little to distinguish the Khiam and Helwan point except the latter's tang.

6) The Jericho point (fig. 4.1:10 and 11). Jericho points are distinguished by distinct, relatively long, tangs with wings rather than shoulders. They have no notches. Bar-Yosef (1981, 559-560, fig. 2:F) would include examples without wings but with sharp 90° angled shoulders, I would suggest that these would grade too easily into Byblos point types and I use the wings as the essential definitional criterion, as I believe Crowfoot Payne, the first to define the type, intended from her description of the Jericho examples (Crowfoot Payne 1983, 679).

7) The Byblos point (fig. 4.2). This point type is distinguished by its distinct tang and shoulders without barbs, perhaps, but not necessarily, more classically rounded. It seems worth distinguishing Byblos points with extensive bifacial retouch as this is a variable with almost certain chronological significance (see below).

8) The Amuq point (figs. 4.3:5 and 6; 4.4:1 and 3). A point where the tang area is not separated from the body by distinct shoulders. Amuq points often display relatively extensive and continuous retouch (frequently executed by pressure flaking) from tang onto body. This point type is an elongated ovate form (Bar-Yosef 1981, 559-561, fig. 2H).

Late Neolithic point types are, typologically, diminutive versions of their PPNB counterparts described above, some of which continue into the Late Neolithic alongside the smaller types into which they grade (Gopher 1989, 52). Bar-Yosef (1981, 561) was the first to formulate the decisive, but arbitrary, 40 mm. dividing point to distinguish the following, mainly Late Neolithic, types from their larger counterparts. These smaller Late Neolithic points usually have relatively extensive, often covering and/or bifacial retouch (Bar-Yosef 1981, 561, fig. 2:I)).

9) The Nizzanim point (figs. 4.3:7-10; 4.4:6). Essentially a diminutive version of the Byblos point, this type is, therefore, distinguished by a tang and shoulders. It is less than 40 mm. long and usually has relatively extensive, often covering retouch (Bar-Yosef 1981, 560-1, fig. 2:I:2). This is Crowfoot Payne's Type B at Jericho (1983, 708, fig. 333:3 and 4).

10) Herziliya point (figs. 4.3:11-14; 4.4:4 and 7). Less than 40 mm. long, this is a point without distinct tang or shoulders, and is therefore a small version of the Amuq point. It also has relatively extensive, very often covering retouch (Bar-Yosef 1981, 560-1, fig. 2:I:3). This is Crowfoot Payne's (1983, 708, fig. 334:3) Type A at Jericho.

11) Haparsah point (fig. 4.4:5). These are small points with tang and wings, less than 40 mm. long, with extensive often covering and/or bifacial retouch (Bar-Yosef 1981, 560-1, fig. 2:I:1). This is Crowfoot Payne's Type C at Jericho (1983, 708, fig. 333:1-2).

12) Transverse arrowhead (fig. 4.4:8). These are formed by the bitruncation of the mesial segment of a blank, usually blade or bladelet. These truncations are usually oblique or oblique and concave, thereby creating what we suppose to be a narrower tang area than the unretouched cutting edge of the supposed arrowhead, formed by the original edge of the blank. Some examples have a rounded base to this tang, creating a more semi-circular form. We do have direct evidence from Early Dynastic Egyptian art and surviving examples of arrows from tombs (Emery 1961, 113-114) that such types, which were in continuous use from Late Neolithic to Early Bronze Age in the Levant and Sinai, were used as arrowheads. This is, of course, not unequivocal evidence that these

pieces were so hafted in the Late Neolithic, but the chronological continuity and geographical proximity of these surviving examples, in the absence of Late Neolithic arrows, is strong circumstantial evidence.

There is other chronologically significant variation in well defined types.

Microliths:

1) The Hagdud truncation (fig. 4.5:8-11)(Bar-Yosef *et al* 1987)(Couze rectangles and variants). This can be characterised as a relatively short (wider than it is long, fig. 8.40), truncated segment of a bladelet or narrow blade. Most frequently it is a mesial section that is truncated with transverse, straight or concave truncations. Sometimes both, often one of these truncations is effected with Couze retouch (Brézillion 1983, 358), often on only part of the break; this characteristic is also observed when the retouch is direct and relatively abrupt. The Couze retouch can be inverse or obverse.

Section 4.2.2 The sequences.

The Jericho sequence remains the most significant, because it has the fullest sequence of point type development over the longest time span. At the beginning of the Neolithic sequence there, the PPNA period, the industry at Jericho, named the Sultanian, is probably characterised by a single point type, the Khiam point. The Hagdud truncation is also present in this phase of occupation on the tell (Crowfoot Payne 1983, 648, fig. 273:5), although only one example was recovered, probably because of lack of sieving. The actual PPNA stratigraphic sequence is quite distinct from the overlying PPNB deposits and a break in occupation, at least in the excavation areas is suggested by erosion gullies (Kenyon 1981, 10-11 and 270). The bulk of the PPNB stratigraphy in the major trenches excavated evidences a considerable degree of continuity from the earliest to the latest depositional units; in several instances the shifting reconstructions of the same buildings can be observed through most of the sequence (Kenyon 1981, 11-13 and 270-271)

In the earliest PPNB deposits, overlying the PPNA, classic Helwan points appear. At Jericho these occur in low numbers alongside a majority of Jericho points and slightly fewer Byblos points (Crowfoot Payne 1983, 683, and fig. 312). In later parts of the sequences Amuq points appear in low numbers. Helwan points appear only at the beginning of the PPNB sequence (Gopher 1985, 119-121).

Because of this development, which covers the full range of PPNB point types, in their order of appearance (that we can document elsewhere) (see below), it might be and has been argued (Gopher 1985, 119-121) that an Early, Middle and Late PPNB sequence is represented at Jericho. Crowfoot Payne who originally analysed the assemblage felt a Late PPNB could be distinguished from an earlier PPNB based on the appearance of Amuq points in the sequence (Crowfoot Payne 1983, 683). The proportions of arrowheads from each part of the proposed sequence (Gopher 1985, 119 table III.3) are almost identical except for the presence of very low numbers of Helwan at the beginning and of Amuq points at the end of the sequence. It could still plausibly be argued that only one period is represented (the Middle PPNB), rather than the whole PPNB, but that the beginning and end of that period are represented at Jericho and therefore transitional elements are present. There are problems with using the large numbers of radiocarbon dates from Jericho, analyzed by different laboratories, under different conditions, by different methods (Waterbolk 1987, 41), but they might well support this picture (see below) and suggest that essentially both typologically and in terms of a quasi-absolute chronology Jericho PPNB is Middle PPNB (see below), that is first half of the 7th M.b.c. (Waterbolk 1987, 41 and fig. 1).

Mureybet, a site on the Euphrates in northern Syria, provides a sequence for the northern Levant comparable with that of the earlier phases of occupation at Jericho. Here some of the same types appear in the same order. The earliest points, added to a late Epipalaeolithic, Natufian(-like) flint assemblage in Phase IB of the occupation sequence documented by J. Cauvin (1987, 326) are Khiam point types. They appear in Level I of Van Loon's excavation (M.C. Cauvin 1978, table 3). Helwan points appear next in the sequence in Phase II of J. Cauvin, Level IV of Van Loon (M.C. Cauvin 1978, table 3). These are followed by tanged points, Level V of Van Loon (M. C. Cauvin 1978, table 3). The precise relationship between these tanged points and classic Byblos points is not clear. In their earliest forms these tanged points, often with inverse retouch on tang and tip and only sometimes limited direct retouch on tang (M.C. Cauvin 1978, fig. 2:5 and 13), are clearly related to the recently identified, usually lozenge-shaped, Nemrik point of the north Mesopotamian pre-pottery Neolithic. These Nemrik points are often formed by inverse retouch on tang and tip and sometimes only limited direct retouch on the tang areas (Watkins *et al* 1989, 21; Campbell and Baird 1991, 75, fig. 4:2-4). Other tanged types in these early phases at Mureybet have very small tangs demarcated by notches, and/or sometimes inverse retouch. This last type, M.C. Cauvin's type 29 (M.C. Cauvin 1978, figs. 1, 5:9, 7:7, and 8:5), is closely related to the variants of Khiam, Helwan and Nemrik points found in these early phases at Mureybet (M.C. Cauvin 1974a, 312). Avi Gopher (1989) in his analysis of Levantine Neolithic projectile points, by implication, does not include these points as Byblos types. He includes such points, lozenge-shaped and/or with limited or fine tangs, in a third category of El Khiam point (Gopher 1989 fig. 1: A2-III). It may be that some of these points with fine tangs could be related to small tanged points of the PPNA of the southern Levant, such as the Jordan valley point. Gopher identifies the appearance of Byblos points in J. Cauvin's Phase III. However, he points out that these last are a very particular type of large coarse Byblos point, Gopher's type A18 (Gopher 1989, 48). M. C. Cauvin, too, feels that these early tanged points should not be classed as true Byblos points. She feels that Byblos points evolve from these types and do not appear until J. Cauvin's Phase IV (M.C. Cauvin 1974a, 317 and J. Cauvin 1987, 328-9). The author's position (as is that of Gopher) is that by Mureybet IIIb (Van Loon's levels XV-XVII) these early tanged points have developed a distinctive form and that by all essential definitional criteria they are inseparable from Byblos points. Examples from these levels at Mureybet with distinct tangs formed by direct, relatively abrupt retouch and clear shoulders are illustrated by M.C. Cauvin (1978, fig. 7:1 and 5). Classic Jericho points are absent from the northern Levant (Gopher 1989, 48).

The sequence at Tell Aswad in the Damascus basin in southern Syria indicates the existence of a Helwan point dominated assemblage in Phase Ia (Contenson 1983, 58). Byblos points only appear in Phase Ib (M.C. Cauvin 1974b). Amuq points appear in Phase II (Contenson 1983, 59).

At Ghoraife, another site in the Damascus basin close to Aswad, Phase 1a has Byblos points without Khiam or Helwan points (M.C. Cauvin 1975-77). In the succeeding Phase Ib Amuq points appear. In Phase II covering, often bifacial, pressure flaked retouch becomes much more common on points of both Byblos and the now more frequent Amuq type (M.C. Cauvin 1975-77).

At Abu Hureyra, a site just south of Mureybet, on the bend of the Euphrates in northern Syria, a long, deep, three phase sequence evidences some change in point types. In the earliest aceramic Neolithic phase only Byblos points are present (Moore 1975, 60). In succeeding later aceramic Neolithic levels almost all points belong to the Byblos type, but some have 'squamous' pressure flaking. In the obsidian component from this phase there are both Amuq and Byblos points with covering 'squamous' pressure flaking (Moore

1975, 61). In the succeeding early ceramic Neolithic Amuq points appear in flint for the first time and covering 'squamous' pressure flaking becomes more common on Byblos points (Moore 1975, 63).

At Beidha, in southern Jordan, in the highland strip on the eastern edge of the Wadi Arabah, early levels VI-V are dominated by Byblos points, by Byblos points with sharply angled shoulders that verge on wings and Jericho points which have only slight wings. Clearly these types at Beidha are all closely related (Mortensen 1970, table IIa, figs. 13-15 and 19). Neolithic levels preceding VI exist but their flint assemblages have not yet been documented. In level IV Amuq points appear and rise in importance to 12% in level I (Mortensen 1970, table IIa and figs. 16 and 19). Helwan and possibly Khiam points occur in low proportions throughout the stratigraphy. Levels III-I mark the dramatic introduction of a new, very different architectural entity, that is rectilinear corridor buildings (Kirkbride 1966, 1967, and 1968). Level IV seems to mark a palimpsest of stratigraphic entities rather than a coherent building phase. It is distinct only because of its intermediate position between the two discrete set of stratigraphic entities in levels VI-V. VI-V have a distinct circular building tradition, and III-I have multi-chambered rectangular sub-structures (Kirkbride 1966, 1967, and 1968). Other chipped stone types change in importance between levels IV/III-I and earlier levels (Mortensen 1970, table II). It is true that Mortensen argues for clear continuity in the chipped stone tool assemblage, based on the relatively similar proportions of global types throughout the sequence (Mortensen 1973, 156-157). It is important to note that the types are focussed on, for this analysis, only at the most general level - borers, burins, scrapers etc (Mortensen 1973, fig. 1). If the more specific variants of each type group are considered as proportions of those type groups, such as the burin type group and the borer type group, for example, where such types are clearly distinct entities, there are much clearer indications of a change coinciding with the introduction of new architectural entities in level III. These types include borer type B5 which may be related to the Amuq points (1-6% in levels III-I, absent from IV-VI) (Mortensen 1970, table IIa and fig. 21), crested blades used as points or borers, dihedral burins (IV-VI 42-52%, III-I 18-26%) (Mortensen 1970, table IIa and figs. 25 and 26), transverse burins on retouched edges (IV-VI 5-10%, III-I 18-23%) (Mortensen 1970, table IIa and fig. 26) and transverse burins on truncations (IV-VI 43-48%, III-I 52-59%) (Mortensen 1970). It is quite possible that there is a stratigraphic break at Beidha and that the appearance of Amuq points there marks a very distinct phase of occupation.

At Ain Ghazal a long sequence has also been documented. Currently detailed presentations of the point types and their occurrence through the stratigraphy are lacking. We know that Jericho, Byblos and Amuq points occur in PPNB levels (Rollefson and Simmons 1988, figs. 2-5). The advent of the PPNC is partly defined by the occurrence of smaller Late Neolithic-related point types alongside Byblos and Amuq points (Rollefson and Simmons 1988, 412 and table 4).

Section 4.2.3. C14 dated sequences.

A C14 based chronological framework can be assigned to these sequences and help provide a broad outline for periodization. In conjunction with dates for assemblages where occupations did not include a period of significant change in the presence of projectile point types we can construct a framework, consisting of chrono-geographic units, defined by distinct projectile point assemblages and assign other known C14 dated sites to these periods.

We can state that Khiam points have appeared throughout the Levant from Sinai to the Euphrates by the late 9th M.b.c. usually joining late Epipalaeolithic-type assemblages with microliths of broadly Natufian character. Dates from Abu Maadi (fig. 4.7, table 4.3), possibly Jericho (Burleigh 1983, 761), and Mureybet 1a (fig. 4.8, table 4.4) indicate this. Helwan points have apparently also appeared by the end of the 9th M.b.c. at Mureybet (table 4.4, fig. 4.8). There, during Mureybet IIIa and at Aswad Ia in southern Syria, they are important in assemblages with greater or lesser proportions of Khiam points in the first half of the 8th M.b.c (fig. 4.8). In Palestine a different situation seems to pertain in the first half of the 8th M.b.c. At Jericho, despite the systematic inter-laboratory variation in sets of dates (Waterbolk 1987, 41), all sets indicate that Khiam points and possible related types are the only points in the assemblage during this period. The small sample of points might suggest some caution, but a series of other sites with sets of dates of this time range clearly indicate assemblages with Khiam points and related variants (the Jordan valley point and Salibya points) exist in the first half of the 8th M.b.c. These PPNA sites are Netiv Hagdud, Gilgal, and Gesher all, however, within the Jordan valley (Bar-Yosef *et al* 1991, 421, fig. 14).

The dating of these assemblages should provide a *terminus post quem* for the appearance of the Helwan point in the southern Levant. The Helwan point, therefore, appears in the southern Levant some time after the middle of the 8th M.b.c. and before the late 8th/early 7th M.b.c. The *terminus ante quem* is provided by C14 dated assemblages at Jericho (Waterbolk 1987, 41-42 and graph 1) and Beidha (Mortensen 1970, 13) where Helwan points appear as small components of, or residuals in, assemblages dominated by Jericho and Byblos points, and dated to the late 8th-early 7th M.b.c. There are sites in the southern Levant dominated by Helwan points, with significant proportions of Khiam points (and possibly with Jericho and Byblos points in lower proportions as genuine parts of their assemblages). These assemblages presumably derive from the period between the end of the PPNA (Khiam dominated assemblages) and the period of Jericho and Byblos point dominated assemblages. There are no dates from these sites which are Nahal Lavan 109 (survey site) (Gopher 1985, 176-180), Mujahiya (Gopher 1990), Jebel Queisa (Henry 1988, 32) and probably Nahal Oren (Gopher 1985, 224-5 and 1989, 48). The fact that this phase is substantially over by the late 8th/early 7th M.b.c is indicated by the dates from Ain Ghazal (Rollefson 1989, 135) where Helwan and Khiam points are absent or have never been mentioned in a series of preliminary publications. It is also indicated by dated sites Beidha and Nahal Hemar (fig. table) where Helwan points are very rare. A phase of Helwan point dominance, a classic Early PPNB, may therefore be documented in the southern Levant (contra J. Cauvin 1989, 177; cf. also Gopher 1990, 140-141) and it probably belongs to some part of the second half of the 8th M.b.c. However, we cannot completely exclude the possibility that even in some parts of the southern Levant, out side the Jordan valley, it may be dated to a late part of the first half of the 8th M.b.c. as well.

These dates strongly suggest a diffusion of the Helwan point type from Syria to central Palestine (area around the Jordan valley) between the first and second half of the 8th M.b.c., although not necessarily a progressive diffusion from north to south as Avi Gopher would argue (Gopher 1989, 49) (we do not have any assemblages from the Damascus basin for the period preceding the early 8th M.b.c.). Such information is clearly essential in helping us document the diffusion of technology through the prehistoric Levant, but it also indicates that we cannot apply the same periodization to north and south Levant or expect them to be precisely synchronized. The assumption that all point types appear later in the southern Levant than the northern (Gopher 1989, 55) may well be false as the case of the Amuq point may indicate (see below).

As the Hagdud truncation from the Jericho sequence indicates these types are associated with PPNA assemblages in the south and central Levant. They also occur in significant numbers at Hatoula (Lechevallier *et al* 1989, 4-5)), Netiv Hagdud (Bar-Yosef *et al* 1991, 412-415), and Gesher (Garfinkel and Nadel 1989, 146). These last two sites are dated by C14 to the first half of the 8th M.b.c. There is an indication that the Hagdud truncation is a part of slightly later assemblages as well. It occurs as part of an undated Early PPNB assemblage at Mujahiya (Gopher 1990, table 2 and fig. 7:3). It occurs at Sefunim terrace in a context (layer V) with an undiagnostic assemblage (Ronen 1984, 339-356 and fig. 22:7 and :8). A hearth in layer V produced two plausible C14 dates of 7,445 ± 130 b.c. Hv-3368 and 7,170 ± 85 b.c. KN-I-366 (Ronen 1984, 342). In each post-PPNA site only one Hagdud truncation is involved, however, so these indications should be treated with caution.

Byblos points appear in significant proportions in assemblages in the second half of the 8th M.b.c. in Syria, at Mureybet and Aswad Ib (fig. 4.8, table 4.4), if not earlier at Mureybet (first half of the 8th M.b.c.). This depends upon the definition of Byblos point chosen, earlier according to Gopher and I, later according to the Cauvins .

In the southern Levant, Byblos points and Jericho points have probably appeared by the late 8th M.b.c. at Ain Ghazal and Jericho and definitely in the first half of the 8th M.b.c at these sites and at Beidha, Yiftahel (Garfinkel 1987, table 1), Nahal Hemar (table 4.3), possibly Nahal Divshon (table 4.3)(Servello 1976, 350 and fig. 12-7). They may occur first, somewhat earlier, as small proportions of point assemblages dominated by Helwan and Jericho points; Abu Salem (Gopher 1985, 144-147) and Mujahiya (Gopher 1990, 123-126).

In the northern Levant Amuq points appear in the first half of the 7th M.b.c. (Aswad II) (ig. 4.8, table 4.4).

In the southern Levant Amuq points probably appear in low to moderate proportions in the first half of the 7th M.b.c. There are low proportions at Yiftahel (Gopher 1989, table 3)). Whilst all the dates from Beidha are in the first half of the 7th M.b.c., only two come from levels III-I (Mortensen 1970, 13). Given the likelihood of a break in stratigraphy and the possibility that these two dates may be residuals, we cannot state with certainty that Amuq points appear here before 6,500 b.c. They occur in low proportions at PPNB Munhata (Gopher 1989, table 3), but in such low numbers that we cannot rule out the possibility that they are intrusive, given the presence of Late Neolithic occupations overlying the PPNB (Perrot 1964 and 1966).

In both north and south Levant Amuq points do seem to become more frequent through the 7th and into the 6th M.b.c. This is reflected both in the way that they are encountered at more sites and that at sites with sequences, or in circumscribed geographical areas with local sequences, they become a larger part of point assemblages through the sequence. This is clear from sequences at Aswad, Ghoraife, Abu Hureyra, Beidha, and Jericho (see above). At Ghoraife (M.C. Cauvin 1975-1977), Abu Hureyra, and Beidha pressure flaking, on both Byblos and Amuq points (Mortensen 1970, table IIa and figs. 16-17), becomes more common through the sequence. The C14 and relative chronologies do not suggest that such developments were in any way in step. Thus at Abu Hureyra Amuq points only appear in flint in the early Ceramic Neolithic levels c. 6,000 b.c (Moore 1975, 63). At Ghoraife this process occurs from first half of the, to the later, 7th M.b.c (Contenson 1983, 59-60). At Aswad II all dates belong to the first half of the 7th M.b.c. (fig. 4.8, table 4.4).

We can say that Amuq points are a relatively common component of many sites dated to the second half of the 7th M.b.c. sites: Ujrat el-Mehed (Gopher 1989, table 3), Wadi

Tbeik (Gopher 1989, table 3), Nahal Issaron (Gopher 1989, table 3), and Ghoraife IIb (M.C. Cauvin 1975-77).

The small points which characterise the Late Neolithic in the southern Levant appear c. 6,000 b.c. or just after. Their occurrence in the PPNC at Ain Ghazal is C14 dated to between 6,100 and 5,700 b.c. at 2 sigma (Rollefson 1990, 120). The appearance in Ghoraife IIb (M.C. Cauvin 1975-77) of a relatively large number of relatively small points some time in the second half of the 7th M.b.c. may mark the beginning of this process.

The sequence of appearance of the Late Neolithic point types in the southern Levant is difficult to document in the absence of a well stratified sequence. Numbers were too limited at Jericho. Perhaps Ain Ghazal may offer an opportunity to effect this. We must rely on well dated assemblages from short occupations to reconstruct the sequence of developments. We know from Pottery Neolithic sites in Palestine and Jordan and Late Neolithic sites in the surrounding steppe and deserts that Herziliya, Nizzanim and Haparsah points and Transverse arrowheads had all appeared by the second half of the 6th M.b.c. The sites of Burqu' 03 (Betts *et al* 1990, 19), Burqu' 27 (McCartney 1992), Dhuweila Phase 2 (Betts 1988b, 384) and Jebel Naja (Betts 1988b, 379) (fig. 4.7, table 4.3) indicate this. The order of appearance of these types and a chronological framework for this sequence has remained elusive until now (section 4.4.6, table 4.1). Avi Gopher has provided a seriation (Gopher 1989, 53), but it remains untested in terms of stratified sequences or C14 dated sequences. However two aspects support his reconstruction of developments in what must be the earlier part of this sequence. There are some assemblages with Late Neolithic point types and with relatively high proportions of Byblos and Amuq points (Gopher 1989, 53). Since these point types are important in the Late PPNB it would be appropriate to suggest that Late Neolithic point assemblages with high proportions of such should be dated close to the end of the 7th M.b.c (sections 4.4.5 and 4.4.6). Secondly two key sites with such assemblages are Byblos (Néolithique Ancien) and Sha'ar ha Golan and their pottery assemblages also place them relatively early in the Pottery Neolithic. If we look at the small point types in these two assemblages, unfortunately recovered without sieving, we note that Transverse arrowheads are absent and Haparsah and Herziliya points occur in low proportions in comparison to the Nizzanim point. We must be careful, however, in utilising the assemblage from Byblos. It is situated relatively far north in the Levant and the small points found in the southern Levant are not features of north Levantine assemblages in the Late Neolithic, where Byblos and Amuq points continue as the main types (El Kowm sites, Amuq A, Ras Shamra). We have here some indication that the Nizzanim point was relatively important compared to other types in the early Late Neolithic, but it clearly requires confirmation. We certainly cannot take the absence of Transverse arrowheads in unsieved assemblages at face value because of their small size and consequent low visibility in the absence of sieving. It seems clear from C14 dated assemblages e.g. Kvish Harif (Gopher 1989, 54) and the presence of only Transverse arrowheads on Chalcolithic sites e.g. Abu Hamid (Dollfus *et al* 1988, 588) that this latter type became more important through time and dominated assemblages by the second half of the 4th M.b.c.

Section 4.3. Summary periodization.

Periodization, that is the composition of chronological units on the basis of a conjunction between C14 based units of time and distinct point assemblages, is relatively clear cut in the southern Levant in the light of the current evidence.

Section 4.3.1. South Levant.

1) PPNA: Khiam point (possibly with some closely related sub-types) assemblages with Jordan valley and Salibiya points and Hagdud truncations occur. Naviform cores are absent (section 7.1.1.1). These assemblages last from the late 9th through the first half of the 8th M.b.c.

2) Early PPNB. Helwan points dominate assemblages. Often Khiam points are represented, possibly Hagdud truncations. Possibly a few Byblos and/or Jericho points are present. Naviform core technology is also present (section 7.2.1). This period must date somewhere between the middle and the end of the 8th M.b.c. No C14 dates directly dating the period are available; it is possible that the period is relatively short, if one for example, took account of the latest set of dates from Jericho and/or the earliest set of dates from 'Ain Ghazal.

3) Middle PPNB. Assemblages are dominated by significant proportions of Jericho and Byblos points. Helwan points are absent or occur in very small proportions, possibly as residuals in those assemblages where they occur. Small proportions of Amuq points may be present. This period must be dated between the late 8th and middle of the 7th M.b.c.

4) Late PPNB. Assemblages are dominated by Byblos and/or Amuq points. Jericho points are absent or very rare, and where they occur they may of course be residuals. Dates indicate the second half of the 7th M.b.c. for this period.

5) Early Late Neolithic (including the PPNC). Presence of high proportions of Byblos and Amuq points and/or significant proportions of Nizzanim and Herziliya points and possibly very low proportions of Haparsah points and Transverse arrowheads. To be assigned to the first half of the 6th M.b.c. It may possibly be a relatively short period.

6) Later Late Neolithic. The presence of significant proportions of Nizzanim and Herziliya points is attested, Haparsah points and Transverse arrowheads are relatively common and some Byblos and Amuq points may be present. Such assemblages are certainly to be assigned to the second half of the 6th M.b.c and into the 5th. This period may start earlier than this and it is unclear when it ends.

7) Final Late Neolithic-Chalcolithic. Transverse arrowheads dominate, possibly occasional Nizzanim, Herziliya and Haparsah points are present. The beginning of this period is unclear, 5th M.b.c.?, it ends late 4th/early 3rd M.b.c.

There is no indication that these Late Neolithic periods, constructed on the dating of chipped stone point assemblages, should coincide with periods defined by pottery assemblages. Given a degree of geographical variation in the Pottery Neolithic ceramic assemblages the extent to which they can be used to effectively characterize chronological units is still unclear. Further, since many, even relatively late Late Neolithic sites in the arid zones (Kvish Harif, Burqu' 03, and Burqu' 27) are aceramic, such ceramic periodization cannot be used in the arid zones. This factor is compounded, in the case of the Early Late Neolithic, when Early Late Neolithic flint assemblages may occur on aceramic (PPNC) sites (Ain Ghazal and Basta) in the moister areas, as well as on perhaps contemporary or only slightly later sites with ceramics, such as Sha'ar ha Golan (and Byblos). Whereas, in the arid zone, sites with Early Late Neolithic point assemblages may be contemporary with first aceramic and then ceramic sites. There are some indications of the overlaps between the ceramic-assemblage-based periods and those proposed on the basis of chipped stone. Thus the evidence of Sha'ar ha Golan may suggest that Yarmoukian (and thus associated PNA) assemblages start during the Early Late Neolithic and the evidence of Ain Rahub (Muheisen *et al* 1988) indicates that they continue into the Late Late Neolithic, certainly covering a significant part of the 6th M.b.c.

For assemblages where C14 dates are absent it becomes clear that the presence of significant proportions of Khiam, Helwan, Jericho, Amuq, Nizzanim, Herziliya and Haparsah points and Transverse arrowheads can assign a site to a particular period. Within the 7th M.b.c., however, there are sites dominated by Byblos points, to the virtual, or total (e.g. Azraq 31 Late PPNB, table 4.1), exclusion of other types and these can only be assigned to Middle or Late PPNB on the basis of C14 dates.

In the northern Levant periodization is more difficult. There is a phase, at least at Mureybet, where Khiam points appear in assemblages as the only point type; this may be a very short-lived phase. They are quickly joined by Helwan points, probably before the end of the 9th M.b.c. and assemblages of the first half of the 8th M.b.c. have significant proportions of Helwan points and Khiam points (as well as a naviform core technology). These are the characteristics of the Early PPNB of the southern Levant, but a large number of C14 dates from both Aswad 1a and Mureybet do indicate contemporaneity of the northern Early PPNB and the PPNA of the southern Levant.

Section 4.3.2. North Levant.

1) PPNA/Early PPNB: Khiam and Helwan points dominate. Possibly some Byblos points are present. Period lasts from late 9th through first half of the 8th M.b.c.

2) Middle PPNB: Byblos points are present in significant proportions, possibly with some Helwan points. Period dated to second half of the 8th M.b.c.

3) Late PPNB: Byblos points are present, without Helwan points. There are possibly some Amuq points which increase in importance through time, although not at all sites (cf. Abu Hureyra). This period covers the 7th M.b.c. Distinction between first and second half of 7th M.b.c. possible only on basis of C14 dates, although proportions of Amuq points and of pressure flaked points may be partially indicative.

4) Late Neolithic: There are no small points as in the southern Levant. Byblos and Amuq points are present. Amuq points are relatively common. Ceramic periodization is more reliable than lithic, although ceramics are absent from arid areas (Bouqras, El Kowm) (Cauvin 1987), Tell Ramad (Contenson 1983) for a substantial part of the first half of the 6th M.b.c. Because many Late PPNB assemblages may have similar point types, in similar proportions to those of the Late Neolithic, C14 dates or ceramics are required for site periodization during this time span, at least at the present time.

Section 4.3.3. Sites assigned to periods on the basis of point types alone, not mentioned in text above.

PPNA southern Levant:

Nahal Oren; only Khiam points (Stekelis and Yizraeli 1963)
Hatoula: only Khiam points (Lechevallier *et al* 1989)
Salibiya IX: only Khiam points (Bar-Yosef *et al* 1991, 422)
Iraq el Dhub: only Khiam points (Ian Kuijt pers comm.)
El Khiam: only Khiam points
Dhra (Raikes 1980, 56-60)
Nahal Lavan 108 (Gopher 1989, 47)
Poleg M18 (Gopher 1989, 47)

Abu Salem (Harifian)(table 4.3)

Early PPNB south Levant:

Sabra Ic: Khiam and Helwan points (Gebel 1987, 346-347). Only one Helwan point is illustrated, it is closely related to the Khiam points and grouped by the excavator with them - this may be a PPNA assemblage.

Jebel Queisa: Khiam and Helwan points (Henry 1988, 38)

Early and/or Middle PPNB southern Levant

Nahal Oren: Helwan, Jericho and Byblos points (Noy *et al* 1973, fig. 7; Gopher 1989, 48))

Sefunim: Helwan and Jericho points and a Hagdud truncation (Ronen 1984)

Adh Dhaman: Byblos points (Gebel 1988)

Michmoret 26: Helwan and Jericho points (Gopher 1989, 48)

Nahal Boqer: Helwan and Jericho points (Simmons 1980)

Abu Salem: Jericho and Byblos points dominate, Helwan points are present in significant quantities in the lowest strata (Gopher 1985, 144-147).

Middle PPNB

Munhata: Jericho points occur in high proportions and Byblos points are common, very small percentage of possibly intrusive Amuq points (Gopher 1989, table 3)

Abou Gosh: Jericho points dominate and Byblos points are common, Amuq points occur in low proportions - intrusive ? (Gopher 1989, table 3)(Lechevallier 1978, 46-57)

Ain Qadeis: Jericho points occur in high proportions and Byblos points are common (Gopher 1989, table 3)

Jebel Rubsha: Jericho points occur in high proportions and Byblos points are common (Gopher 1989, table 3)

Middle and/or Late PPNB

Kharaysin: Byblos points occur (Edwards and Thorpe 1986, 86-87, figs. 1-2)

Shaqarat M'siad: Byblos points (Gebel 1987, 347)

Nizzana: Byblos and Jericho points are the significant component of the assemblage with a small proportion of Amuq points (Gopher 1989, table 3).

Nahal Reu'el: Byblos points dominate, Amuq points are present in significant, but not high proportions, with a small proportion of Jericho points (Gopher 1989, table 3).

Ramat Matred V and VI: Byblos points dominate, Jericho points form a significant and Amuq points a small, but distinct proportion of the assemblage (Gopher 1985, 181-2).

Mushabi VI: Byblos, Jericho and Amuq points are present (Mintz and Ben Ami 1977).

Abu Maadi III, lower: Byblos and Amuq points are important, but equally important is a distinct type, Avi Gopher's type A40 - perhaps derived from Helwan and Jericho points (Gopher 1985, 91).

Late PPNB

Gebel Gunna: Amuq points dominate (Bar-Yosef 1981c)

Baga: Amuq points dominate (Gebel 1987, 347)

Beisamoun: Amuq points important (late sickle types present) (Lechevallier 1978, 157-160 and fig. 55)

Wadi Jibba I: Amuq and Byblos points dominate (Gopher 1989, Table 3)

Abu Maadi III upper: Amuq and Byblos points dominate, a small component of Jericho points is present (Gopher 1985, 91, table III.1).

Late PPNB and/or Early Late Neolithic

Ibn el-Ghazzi: Byblos and possibly Nizzanim points (Betts 1985, fig. 15)

Wadi Ahmar 509: Amuq points dominate, Byblos and Nizzanim/Herziliya present (Petrie 1906)

Ain Abu Nekheileh: Amuq points dominate, some Byblos present (Kirkbride 1978, 7-9 and fig. 4).

Umm el-Muqur: Amuq points dominate (Jobling and Tangri 1992)

Early Late Neolithic:

Qadesh Barnea 3: Byblos and Amuq points dominate, Nizzanim points occur in significant proportions and Haparsah and Herziliya points occur in very low proportions (Gopher 1989, table 3).

Later Late Neolithic

Haparsah: Haparsah points dominate, Nizzanim points important, Herziliya and Amuq points occur in low proportions (Gopher 1989, table 3).

Nahal Issaron: Haparsah, Nizzanim and Herziliya points only (Goring Morris and Gopher 1983).

Nahal Sekher 81a: Haparsah and Nizzanim points dominate, Amuq, Byblos and Herziliya points are present (Gopher 1989, table 3).

Earlier and/or Later Late Neolithic

Ghirqa 2331, 2229, 2332: Nizzanim and Herziliya points only (Betts 1987b)
Dhra: PNA pottery present (Bennett 1980)
Abou Gosh: Amuq, Haparsah and Nizzanim points are all important (Gopher 1989, table 3).
Wadi Jibba IIa: Byblos and Nizzanim points important, Haparsah and Amuq points occur in small proportions (Gopher 1989, table 3).

Section 4.4. The chronology of the Azraq basin Neolithic sites and the implications for the wider chronological framework of the Azraq basin projectile point assemblages.

Section 4.4.1 Wadi el-Jilat 7.

At the site of J7, in adjacent areas A and C (figs. 4.10-4.12), a clear stratigraphic sequence independent of C14 dates or point assemblages can be documented. The earliest phase in these 2 areas is characterized by a series of ashy occupation-like sediments which were deposited immediately preceding the construction of, and which accumulated inside and outside, 3 structures (Structures **1, 2**, and **3**)(fig. 4.12). The major loci, providing the bulk of the flint assemblage of this phase, are A34a and b, A25a and b, Ab23 and C6a. The point assemblage from these deposits consists of just under one quarter Khiam points and related types and just under three quarters Helwan points (fig. 4.1:7 and 8; table 4.1). Byblos points hardly occur. In fact, only 1 example was recovered amongst a large sample of points from these deposits. This was found near an area of disturbance in Area C, where the eastern wall of Structure 1 may have been robbed out (fig. 4.12), so this point may well be intrusive. This piece should not be dismissed too easily, however, as it is rather different from the Byblos points from later deposits. It is relatively small, with a very fine tang, made on distinctive, lustrous yellow raw material (part of the exotic red group - sections 6.2.9 and 6.6.2-6.6.4) very similar to the material used for Khiam and Helwan points, and differing from the typical local raw material, which is that usually used, in the later phase, for the manufacture of the larger Byblos points. A single Jericho point was recovered from these loci. It is closely related to the associated Helwan points, merely lacking the notches. This may suggest that Jericho points evolved from Helwan points when the notches became 'redundant'. Associated with the Helwan and Khiam points are significant proportions of Hagdud truncations (table 4.1). Opposed platform production with some naviform cores is present in this Early Phase (fig. 6.5:1)(sections 6.9-6.10). This is clearly an Early PPNB assemblage. One would expect it to belong to the second half of the 8th M.b.c. (section 4.3.1).

2 samples from these loci were dated by the Oxford accelerator. OxA-1799 from A34b produced a date of 3,890 ± 100 b.c.; this is clearly thousands of years too late to be genuinely associated with any PPNB assemblage, let alone one of the Early PPNB. It is possible that we may have dated an intrusive sample from some period of Chalcolithic activity on the site. It is, however, suspicious that activity of that period has left absolutely no detectable archaeological traces at all. Evidence of activity of that period is very clear at the site of J27 a few hundred metres to the south of J7 (fig. 3.4); J27

indicates that this period is not archaeologically invisible in our area of the steppe/desert. It may be then that this rogue date is a product of the vagaries of the dating process itself. A second date OxA-2413 came from a sample from A34a and yielded a result of 6,440 ± 80 b.c. This date indicates the period of the Late or late Middle PPNB and cannot be associated with an assemblage with such obvious Early PPNB characteristics. It is a moot point whether this is a completely meaningless date or whether it is intrusive to these early loci on J7, but actually dates some phase of PPNB activity on J7, perhaps the latest represented. There is plausible evidence for a sequence of 7th M.b.c. occupations on the site and this date may relate to one of these occupations. It would thus represent an intrusive piece of charcoal in the deposit from which it was recovered. It may even relate to the phase of occupation dated by OxA-527 - there is considerable overlap at two standard deviations (fig. 4.7) (see below). It may, however, be an inaccurate date.

This clear Early PPNB assemblage is strong evidence that an Early PPNB is indeed present and very distinctly characterized in the southern Levant. It is characterized in essentially the same terms in the southern Levant as the northern, albeit occurring later in the south than the north. There is one exception and that is the presence of Hagdud truncations in the south, which the evidence from J7 clearly indicates are part of Early PPNB assemblages, the evidence was previously inconclusive. Until recently only a few sites (see above) could be tentatively assigned to such a phase. This allowed J. Cauvin to suggest that the Early PPNB was confined to the northern Levant (J. Cauvin 1989, 177) or Rollefson (1989, 168-169) to suggest that the presence of the Early PPNB in the southern Levant remains unclear, something the very distinct evidence from J7 now refutes.

Overlying J7 Structure **1** were a series of deposits, clearly derived and lacking evidence of clear features or structures. To the west in Area A, however, were a sequence of fragmentary structures overlying the earliest phase loci and in turn cut by a distinct structure, Structure **4** and its associated structural units (fig. 4.12). The fills, in and around and post-dating these later constructions, have significant proportions of Byblos points in their point assemblage, although Helwan and Khiam points and Hagdud truncations occur in some numbers as well (table 4.1 - part of Phase II numbers). It is difficult to know whether some or all of these last three types may have derived from the earlier deposits. Many of the structures on the site were constructed by first cutting into and removing earlier deposits. Given this and a general expectation of some derivation of artifacts from earlier deposits on any archaeological site, it seems likely that some, at least, are residuals. We have some grounds for believing, given the evidence from Structure 5 (see below), that such Early PPNB points and Hagduds could be quite common residuals. If not all were residuals then such an assemblage with Helwan, Khiam, occasional Jericho and Byblos points and Hagdud truncations would be likely to be some sort of Early-Middle PPNB transitional assemblage. If all the Khiam and Helwan points and Hagdud truncations are residuals then the assemblage could be either Middle or Late PPNB of the late 8th to 7th M.b.c. In the absence of C14 dates and stratigraphic connections between the different areas on the site it is impossible to be sure of the status of the upper deposits in Area A. The evidence from Structures 5 and 6 clearly has a bearing on the issue. However, particularly in the light of the similarities and differences in technology (section 6) and tool types (section 8) between the different phases in the different excavation areas we cannot be conclusive in this regard.

The whole of Area B consisted of one structure, Structure 5 (fig. 4.13). A sequence of deposits filling this structure could be broken into 2 major phases of deposition because of the nature of the deposits themselves, in conjunction with changes in tool types and technology (see sections 6 and 7). The lower deposits included J7B33a, J7B29a, and J7B36a which were selected for analysis of the chipped stone. These represent two episodes of deposition. The earlier immediately overlay bedrock, and related to use of the bedrock surface, indicated by the burning of that surface in a hearth area and the episodes of deposition. The earlier immediately overlay bedrock, and related to use of the bedrock surface, indicated by the burning of that surface in a hearth area and the presence of a cache of 4 large blade tools on bedrock in J7B. A second episode included construction of a platform in the north of the structure and its use. Deposits belonging to these episodes were dark grey and had a character that suggested a significant component of occupational debris. The upper deposits (included loci J7B16d, J7B11a, and J7B6a selected for detailed analysis of the chipped stone) contained more wind blown silts than earlier deposits and considerable quantities of rubble. These deposits may not represent an occupation of the structure. One deposit J7B9a, which lay between deposits belonging to these 2 episodes could not confidently be assigned to either. The point assemblage from both these phases consists of the potentially residual Early PPNB types and Byblos points (fig. 4.2:1; table 4.1). On these grounds the uses of Structure 5 could date anywhere from the Early-Middle PPNB transition to the Late PPNB i.e. late 8th through 7th M.b.c. The evidence of tool types and technology (see sections 6 and 8) suggests, however, that the earlier phase of activity in Structure 5 should be closely related to the sequence represented in the upper phases of Areas A/C and that, therefore, the later phase in Structure 5 post-dates these, but by how long cannot be indicated.

The stratigraphic sequence in Structure 6 immediately adjacent to Structure 5 (fig. 4.13), in the sounding in Squares 5-8 excavated in 1984 and described in Garrard *et al* 1986, evidences a series of developments. The point assemblage from all deposits in this structure is similar to that from Structure 5, that is Byblos points (fig. 4.2) with possibly residual Early PPNB types. The possible periods of occupation represented stretch, therefore, from Early-Middle PPNB transition to the end of the PPNB. The tool assemblage and the technology suggest a phase of occupation similar to that in the earlier part of the sequence in Structure 5 and the upper part of the Area A/C sequence. A tool assemblage similar to that recovered from the upper part of Structure 5 was found only in the surface deposits in Squares 5-8. Fortunately, two samples from Structure **6** were dated by C14. OxA-526 and 527 dated deposits relatively early in the sequence exposed in the structure. OxA-526 6,860 ± 110 b.c. dates the primary occupation of the structure and OxA-527, 6,570 ± 110 b.c. dates a secondary occupation. These dates overlap so both phases may belong to the same period, but equally there may be a somewhat later occupation episode. Whether they belong to the same phase of occupation or not, the evidence strongly suggests that this structure was constructed and first occupied during the Middle PPNB. Further occupation may have also been in the Middle PPNB or possibly in the early Late PPNB. The assemblage from the surface deposits in Squares 5-8, similar to that in the later phase of activity in Structure **5**, should belong to a phase of activity later than these and could therefore fall within the Middle PPNB or even the Late PPNB. It is interesting to consider whether OxA-2413 (6,440 ± 80 b.c.) from A34a might date this phase of activity on the site, but we can say nothing conclusive.

The C14 evidence from Structure **6** does help us in assigning periods to the activity in other areas. If the earliest occupation in Structure **6** dates to the Middle PPNB, the first half of the 7th M.b.c., then it becomes clear that most, and probably all, the Khiam and Helwan points and Hagdud truncations in these deposits in Structure **6** are residuals. This conclusion is based on the fact that such points are very rare indeed in contemporary (first half of the 8th M.b.c.) occupations and when they do occur may well be suspected of being residuals. They are absent, for example, from the sequence at Ain Ghazal, rare at Jericho, Nahal Hemar and Beidha (section 4.2.2). If they are residuals in the Structure **6** assemblage it is more plausible that they are residuals in the very similar point, tool and technological assemblages from the upper parts of the Areas A/C sequence and earlier sub-phase in Structure **5**. It therefore seems plausible that a substantial part of these occupation episodes belong to the Middle PPNB.

Summary of the J7 sequence.

To summarize, 3 distinct periods of occupation are separable on J7. The earliest, represented by the lowest deposits in Areas A/C, J7 Phase I is Early PPNB. The second period is represented in lower deposits in Structure 5 whose point and tool assemblages resemble those of Structure 6 and the upper deposits in Areas A/C. The upper deposits in A/C may contain many residuals from immediately underlying PPNB deposits or represent an Early-Middle PPNB transitional assemblage. These episodes may not be contemporary, but all belong to Middle PPNB, whether earlier or later. In broad terms these occupations are grouped as J7 Phase II. In ensuing analysis the Phase II deposits in Areas A/C are treated separately because of their problematic status. In Structure 5 a later set of deposits was characterized by a separate tool and technological inventory (sections 6 and 8). The point assemblage is not different (table 4.1) and no dates are available. This is distinguished as J7 Phase III and may thus belong to Middle or Late PPNB. Various similarities between the assemblages from Phase III deposits and those from Phase II may indicate that the 2 phases are not represented by a great passage of time. The fills from Squares 1-4 excavated in 1984 (figs. 4.10-4.11)(Garrard *et al* 1986) must belong to Phase II and possibly III.

Section 4.4.2. Wadi el-Jilat 26.

Four major areas were excavated on J26, A, B, C and E (figs. 4.14-4.15).

In Area A vestigial deposits were preserved underlying the structure there (fig. 4.16) and cut by it. They were deepest in unconformities in bedrock and under the northern third of the structure, a cell representing a possible later addition. Artifacts were scarce in these volumetrically limited deposits and may include material trampled into the loose sediments during occupation and construction of the overlying structure. The context chosen for analysis from these deposits was J26A5.

Within the structure in Area A no surface, or deposit, that could be related to its occupation/use was isolated. It is unclear whether rough stone platforms or pavements and the third, northern compartment (fig. 4.16) are evidence of a constructional sequence. A probable modification of the entrance between northern and central compartments may indicate temporal developments. The structure was filled with pale brown silts with a high aeolian component. These fills and the artifacts from them may not relate to the occupation of the structure. The bulk of the chipped stone analyzed from this area is from these fills and a small component is from structural entities.

In Area B the sequence is characterized by two main fills. The lower, J26B5a, overlay bedrock and had a higher ash content than the upper, J26B3a, which had more aeolian silts. The only distinctive feature in this area was a hearth cut in bedrock and contained in the lower fill.

In Area C (figs. 4.14; 4.15; 4.17) only very limited deposits preceded the construction of the building in this area. They were preserved under the walls of the sub-structure and adjacent to the building. This building was cut through these deposits to and into bedrock, which thus provided an initial occupation surface, indicated by scorching from a hearth area. Grey, ashy silts relate to this primary occupation (context analyzed J26C7a). Dividing walls were erected and following this further, less ashy, deposits accumulated (contexts analyzed J26C2 and J26C6). An additional occupation episode may be indicated by the placing of a very large slab on a rubble foundation, possibly as a work surface (fig. 4.17). Following this light brown silts filled the structure (context 1). Artifacts from this context may not relate to an occupation of the structure. Some fills outside the structure, overlying the primary deposits in these areas, are believed to have been contemporary with some of the early occupation fills inside the structure (these include analyzed context J26Cc17a). Two hearths, a stone bin, and a solitary upright indicate activity outside the structure in Area C.

Area E (fig. 4.18) had 2 phases of occupation. 2 bedrock mortars or postholes indicate initial use of the bedrock/natural surface here. A further 8 such cut into bedrock where it was exposed as part of the modern ground surface and may belong to this phase. Constructed on bedrock was a rectilinear structure (fig. 4.18), probably fragmentary, having been disturbed by later activity and/or erosion. The fills enclosing these features are distinctly ashy. Set into these early fills were a series of hearths (fig. 4.18), built at different times and during the use of which, silts accumulated, less ashy in character than the underlying.

The site of J26 has very low proportions of projectile points as a whole (whether tool or total chipped stone assemblages are considered). There are only a few points in each area. As can be seen stratigraphic developments in each area were of a limited character, no more than two major episodes were ever evident. The proportions of different tool types varied distinctly from area to area but did not vary through the limited stratigraphic sequences in each area (sections 8.10 and 8.12). This suggests the stratigraphic developments in each area do not mark the passage of great lengths of time because it seems unlikely that discrete and distinctive tool inventories would persist in limited locales on a site if the whole site were constantly reoccupied over lengthy periods and when the functions of some of the areas was changing at least partly. The evidence relating to technology indicated that the reduction strategies were uniform across the site but techniques like tool types may have varied from area to area (section 6.5.4). Opposed platform strategies dominate with naviform and sub-naviform cores present. Byblos (fig.

4.2:7) and Amuq points were present in all areas, except Area E, which had a relatively low density of chipped stone. Amuq points compose about one quarter of the total point assemblage from the site (table 4.1). This is clearly a 7th M.b.c. assemblage. In conventional terms it might be seen as a relatively late (later 7th M.b.c.) PPNB, because of the relatively high proportion of Amuq points (Gopher 1985). Clearly low overall numbers of points would make such an inference very tentative, however. Three C14 dates OxA-2969 6,790 ± 110 b.c., OxA-2407 6,770 ± 100 b.c. and OxA-1802 6740 ± 110 b.c. were obtained. OxA-2407 and OxA-1802 date two sequential fills (the earliest and secondary fills) of the structure in Area C (fig. 4.19) and OxA-2969 comes from a hearth belonging to the latest phase of the sequence in Area E. These samples cover the full stratigraphic development in the eastern part of the site. This obviously contains these developments within the first half of the 7th M.b.c. Some of the kinds of variation in proportions of tool types encountered across the site is also encountered in the sequences from these two areas; in conjunction with the technological homogeneity (section 6) of the flint assemblage and the architectural homogeneity (section 9.1) indicated by the repetition of the distinctive construction techniques, there is much to suggest that occupation of the site belongs to a limited episode or series of episodes within the first half of the 7th M.b.c.

This conclusion naturally raises the question of the chronological relationship of Middle PPNB J7 Phase II and Middle PPNB J26. As Gopher (1985) has indicated the relative importance of Amuq and Jericho points in 7th M.b.c. assemblages may indicate their relative chronological position. On this basis because of the Jericho points on J7 Phase II (fig. 4.1:10) and Amuq points on J26, absent from analyzed contexts on J7 and very rare altogether on the site, it seems likely that J7 Phase II predates J26. We must be cautious, however. The mean of OxA-527 (table 4.3) post-dates the means of the J26 dates and this sample comes from a J7 Phase II context.

The significant proportions of Amuq points in an, albeit small, point assemblage of the first half of the 7th M.b.c. confirms the notable if secondary role of this type in some Middle PPNB assemblages (later Middle PPNB?) such as Yiftahel (Amuq points 17%), possibly Beidha (Amuq points 6-20%), and Ain Qadeis (Amuq points 15%), as in the north of the Levant. There is not necessarily a diffusion of this type from north to south (Gopher 1989, 55).

Section 4.4.3. Wadi el-Jilat 32.

A straight-forward sequence was excavated at J32. The wall of the excavated structure had been set into and on top of a deposit which lay immediately above bed-rock. This deposit contained some artifacts but seemed to be derived mainly from weathered bed-rock. As parallels with other Jilat structures indicated, the manner in which the slabs lent outward, away from the centre of the structure suggested that they lined a cut into an earlier deposit (as in the case of Structure 1 at Azraq 31).

The primary occupation fill was an ashy deposit (0.09 m. thick) containing dense concentrations of bone and flint (context analyzed J32Aa6b). Overlying this was an "occupation-like" deposit (J32Aa5), which was 0.10 - 0.17 m. thick. However, the presence of several large, tilted limestone slabs within this deposit indicated it may not necessarily result from an occupation (*sensu strictu*) of the structure. One slab (0.92 m. long) was evenly dressed and sub-rectangular, tapering at the end into a rounded and relatively thin "head". The slab was lying tilted over other slabs and its thinner "head" was broken off and slightly separated from it - as if it had broken when deposited. It may have stood upright. If it did, it would have been both established and have fallen during the accumulation of locus 5. On the opposite side of the structure were two parallel upright slabs in similar positions to that proposed for the dressed slab. The one closer to the wall was set up during the accumulation of locus 5, or set into locus 5 immediately after its deposition ceased. The inner one was established after the deposition and breaking of the dressed slab. A third, isolated upright at the northeastern end of the structure (0.2 m. from the wall) was established at approximately the same juncture as some of the other uprights. It is thus apparent that during and immediately following the accumulation of locus 5, the structure witnessed a sequence of 'remodelling'. Following this 'remodelling', a deposit accumulated which appeared to contain a mixture of occupation-like material and naturally-derived sediment, with only a limited artifact content (context analyzed J32Aa4b). This was overlaid by 0.38 m. of colluvial and wind blown sediments in which artifacts were very scarce. The careful placement of a limestone mortar over a large basalt pestle in the upper part of these deposits attests to continuing occupation, probably prehistoric, on the site at some point during this depositional episode and at least occasional use of the shell of the structure.

At J32 the sequence of deposits in this structure, the only excavated area, produced only a small number (and small proportion of the tool assemblage) of Byblos points (table 4.1). This would point to a Middle or Late PPNB period of occupation. The surface survey produced Helwan points, however, so there may be an Early or Early/Middle transitional PPNB occupation on the site in addition to the phase represented by Structure 1. Relationships between the tool assemblage and technology on this site and that on J7 may have a bearing in placing the site chronologically, but discussion on broad inter-site variation in the chipped stone assemblages is reserved until the assemblage from each site has been discussed (section 8.10).

Section 4.4.4. Azraq 31.

Five Areas were excavated on Azraq 31, A-C in 1989, (Baird *et al* 1992) and Trench 1 and 2 in 1985 (Garrard *et al* 1987, 21-22) (fig. 4.25).

To summarize, Area A and Trench 1 indicate the following occupation sequence. An initial phase was rather exiguous in character. Following this a group of hearths (belonging to the same phase of activity but not necessarily strictly contemporary) occupied an open area. Accumulating around and over these hearths was a series of ashy occupation spreads. In the later phases of this accumulation a densely packed stone 'platform' was created (Garrard *et al* 1987, 21). No evidence for buildings was found in this area. The early fills in Area A, uncontaminated by Roman-Ummayyad period burials, produced an assemblage of Byblos points (fig. 4.2:3; table 4.1) (contexts analyzed for chipped stone studies Az31A6, and Az31A5). Only Byblos points were recovered from adjacent Trench 1 (fig. 4.3:1) in all except surface deposits. This suggests a Middle or Late PPNB assemblage.

The longest and best preserved sequence was excavated in Area B (fig. 4.26). The lowest deposits, fills cut by, filling and overlying two shallow (as preserved) scoops contained only Byblos points (table 4.1)(contexts analyzed Az31B42 and Az31B24). This assemblage was therefore similar to that in primary fills in Area A and Trench 1. Other similarities in deposit type, tool assemblage and technology of the chipped stone suggest it must belong to the same period as that in Area A and Trench 1, that is the Middle or Late PPNB. Overlying these features and fills was a 0.24 m. thick sequence of alternating, continuous and discontinuous clayey and ashy lenses (all uncontaminated fills were analyzed; Az31B14, Az31B16, Az31B19, Az31B20). Early in the formation of this sequence an upright slab of limestone was established (fig. 4.26). Judging by the character of other structures on this site and those in Jilat this is likely to have formed part of some more extensive structural entity.

These fills were cut by two relatively deep pits (fig. 4.26) which contained Byblos and Amuq points (fig. 4.4:3)(as well as a probably Late Neolithic sickle with bilateral gloss and invasive bilateral and bifacial retouch, fig. 8.1:2)(contexts from which lithics were analyzed are Az31B8a, Az31B23, Az31B33, Az31B34, and Az31B35). The upper part of the sequence cut by these pits consisted of very ashy spreads containing much burnt material. These deposits (context Az31B3) contained only a few points, Byblos and Amuq types, but the rest of the tool assemblage was related to that in cut B12 and therefore was probably Late Neolithic.

One metre to the west of Area B was Area C (fig. 4.26). Here Structure **1** cut a sequence of deposits (context analyzed Az31C15a), of which only the upper part was excavated. However, it was similar to the alternating fills preceding the 2 deep cuts in the upper part of the Area B sequence. Structure **1** was filled with rubble and succeeded by Structure **2** (figs. 4.26 and 4.27). The rubble fill of Structure **1** was also cut by a large pit (fig. 4.26). The earliest fills of Structure **1** (context analyzed Az31C23) and the latest fills excavated in Area C contained Nizzanim points (fig. 4.4:6). Neolithic pottery was recovered from the latest fills, that is from those in the pit cutting the rubble fill of Structure **1** (context analyzed Az31C4g). Almost the whole excavated prehistoric sequence in Area C is therefore Late Neolithic. In these levels, alongside small proportions of Nizzanim points, are Amuq points and Byblos points (table 4.1, Az31LN). As our summary above would indicate such an assemblage, lacking Haparsah points and Transverse arrowheads, but with significant proportions of PPNB types, is likely to belong to the Early Late Neolithic. Given the small size of the assemblage, and the probability that some Byblos points are residuals, this must remain a tentative suggestion.

Trench **2** was disturbed by Roman-Ummayyad period burials dated by OxA-871 to 670 ± 90 a.d. A small amount of prehistoric deposit, immediately overlying natural and adjacent to a rectilinear structure remained undisturbed, however. These fills Trench 2 loci 58 and 60 contained Herziliya points. This clearly Late Neolithic assemblage indicates that before disturbance this Area had only Late Neolithic deposits *in situ*. The complete point assemblage, including that from disturbed contexts, consisted of frequent Nizzanim and Herziliya points, some Amuq points and a small proportion of Byblos and small bifacial tanged points (fig. 4.3:4-13; table 4.1, Az31LNM = Late Neolithic mixed).

There are clearly differences between the Late Neolithic assemblage from Trench 2, albeit mixed, and that from the *in situ* deposits in Areas B and C (table 4.1). Even if many of the Byblos points are residual in these deposits the significant numbers of Amuq points (absent from the Late PPNB at Azraq 31), the low numbers of Nizzanim points and the absence of other Neolithic point types including the Herziliya points so important in Trench 2 support an Early Late Neolithic date for these deposits with a point assemblage so akin to those of the PPNB. This may explain the degree of similarity between the Late PPNB and Late Neolithic assemblage (Late Neolithic material was only analyzed from *in situ* contexts) on technological grounds and in terms of the proportions of general types (sections 6.7.1 and 6.8.4) (appendix 1).

As will be seen below the evidence of J13 and J25 would suggest that this assemblage, albeit mixed, could well belong to the Early Late Neolithic, the absence of Haparsah points and Transverse arrowheads being potentially significant; one or other of these point types occurs in all dated second half of the 6th M.b.c. sites in the east Jordanian steppe, even if in low proportions (Baird *et al* 1992, 27). This, alongside the evidence of other similarities in various aspects of the chipped stone and other facets of material culture between Azraq 31 Late Neolithic and J13 (Baird *et al* 1992) also suggests that the tentative assignment of the Late Neolithic sequence to the Early Late Neolithic is correct. The Trench 2 point assemblage may be later or include later material, but the absence of Haparsah points and Transverse arrowheads is notable.

At Azraq 31 the PPNB in Trench 1 is dated to the second part of the 7th M.b.c., that is to the Late PPNB, by a sample from a hearth cut into natural in this area: OxA-870, 6,400 ± 120 b.c. A second date of this period, overlapping completely with OxA-870, comes from the Late Neolithic sequence in Area C and must presumably be residual from the Late PPNB occupation: OxA-2412, 6,325 ± 80 b.c. It is at least useful as supporting evidence that the PPNB occupation on the site should be placed in the Late PPNB.

Section 4.4.5. Wadi el-Jilat 13.

The stratigraphic sequence within the single, large structure (and immediately adjacent external areas) excavated on J13 is relatively long and complex and demonstrates a sequence of different tool, technological and point assemblages. Point assemblages and stratigraphic developments concern us here. Early Phase, I is distinguished from Phase II by the appearance of a number of new point and tool types. Phase I is marked by a series of distinct depositional episodes. Overlying a series of cuts in bedrock, many of which may be postholes and/or bedrock mortars, contained within a partly natural hollow (fig. 4.20), were a series of pale brown sediments (contexts analyzed J13A23, J13B77). It is unclear whether the perimeter wall of the structure was in existence at this stage. These primary fills were covered by orange-white silts (context analyzed J13A21). The western area of the structure, Area A, was compartmentalized and a paving, platform or wall foundation constructed in the west-central area (fig. 4.21) before a series of distinct white silts were deposited. These white silts (contexts analyzed J13A15a, J13A16a, J13A18a) abut the perimeter wall and were capped by an occupation or deflated surface contemporary with the use of the platform, paving or central wall.

The Phase I deposits, including those on bedrock, within the area of the structure have Byblos, Amuq, Herziliya, and Nizzanim points (fig. 4.4:1, 4, and 7). Nizzanim points are the single most frequent type making up over one third of the assemblage. The relative importance of PPNB types (Amuq and Byblos points) and the absence of Haparsah points and Transverse arrowheads point to an Early Late Neolithic period of occupation. One or other of these last two point types occurs in all dated sites of the second half of the 6th M.b.c. sites in the east Jordanian steppe, even if in low proportions (Baird *et al* 1992, 27).

Upper Phase I deposits hint at developments even within Phase I, Amuq and Byblos points are less common and Nizzanim and Herziliya points much more frequent. Further many of the Byblos points distinguished in these deposits, as in those of Phase II on the site, have extensive covering or bifacial retouch (section 4.2.2). A number are only just over 40 mm. long and thus barely distinguishable from Nizzanim points, except on this arbitrary ground. The Byblos points from the earliest levels are more akin to those of the PPNB, retouch is mostly confined to the tang and they are relatively long.

Phase II deposits indicate a clear sequence of episodes. They are divided up by the laying of an extensive paving across the eastern two thirds of the structure (fig. 4.22). These episodes represent the deposition of relatively deep orange brown sediments (context analyzed J13C39a) that may represent levelling for the paving, the laying of the paving itself and the accumulation of ashy fills (context analyzed J13C3b) over the paving associated with the use of hearths set in the paving at the eastern end of the structure. In the southern part of the structure compartments saw use contemporary with or later than the paving (contexts analyzed J13B4a, J13B7c)(fig. 4.22). A wall divides the western third from the eastern two thirds of the structure and the Phase II sequence is therefore different there. Upper, orange sediments characterize this western part of Area A (contexts whose chipped stone was analyzed there within and outside the structure include J13A5a, and J13A10).

In these Phase II deposits, two significant new components appear in the point assemblage, but not together. In upper deposits in the west end of the structure (Area A) Haparsah points (fig. 4.4:5) appear in small proportions alongside Nizzanim and Herziliya points. In the upper deposits in the east end Transverse arrowheads (fig. 4.4:8) occur in small proportions alongside Nizzanim and a few Herziliya points (table 4.1). Extensively pressure flaked Byblos and a few Amuq points also occur in both sets of deposits (table 4.1). Since the two new point types occur in such low proportions it could be argued that a rather artificial distinction between the assemblages at the east and west ends of the structure has been made. However, it is important for two reasons; 1) the deposits concerned in each of the two portions of the structure are rather different and 2) there are distinctly different tool types associated with the Transverse arrowheads. These appear to be very similar to Canaanean blades (fig. 4.6). Because Canaanean blades are chronologically highly diagnostic of the Early Bronze Age, it is clearly important to discuss them here.

The blades (a total of 7) recovered from late deposits in the eastern part of J13 (C39a, C42a, C3b) are all trapezoidal in cross-section with very regular, relatively straight, parallel edges and ridges (the scar edges on the obverse surface of the blank); they are relatively long and wide (fig. 4.6), as well as far more regular than most blades produced in Jilat assemblages. The ridges on the obverse of the blank are sharp and distinct. All the Jilat examples of these blades have one truncation (fig. 4.6). Some have limited retouch along parts of their edges. Only 1 example has a platform preserved. The point of impact on the platform is plain, but adjacent to this is part of the original platform of the core and it is heavily facetted (fig. 4.6:1). These blades are made on raw material not available in Jilat and no cores were found from which they might have been produced. Such facetted platforms and exotic materials and absence of evidence of on-site production also characterize Canaanean blades. Some of the essential attributes that distinguish this tool type, as with Canaanean blades, are qualitative, involving as they do the regularity of the blanks. Both these blades in Jilat (henceforth Jilat blades) and Canaanean blades, despite the qualitative nature of their defining attributes, are very easily distinguished from other blades in the assemblages in which they occur. At least with the Canaanean blades this has much to do with their mode of production (Baird 1987, 475) and this is likely to be a factor with the Jilat blades as well, even if they are not Canaanean types. There is not enough information relating to the technology of production of the Jilat blades to decide whether they might be related to Canaanean blades in terms of their production. Points of difference are the frequency of truncation of the Jilat blades (all examples) and the fact that none of these blades are sickles - Canaanean blades are frequently sickles and in most assemblages truncations are rare. The absence of sickle gloss may have much to do with the environmental context of Jilat, of course. The points of similarity are the basic character of the blank. On this evidence alone it is difficult to decide whether these blades are variants of the Canaanean blade. If it could be suggested that they were not associated with the Late Neolithic assemblage but, either intrusive in the contexts in which they were found, or that the Late Neolithic material in these contexts was all residual, then the author would probably have no hesitation in judging them to be variants of the Canaanean blade on the distinctive, albeit qualitative morphological attributes of the blanks. No such blades have been illustrated or discussed in other Late Neolithic assemblages.

The appearance of Haparsah points in the upper part of the stratigraphy and rarity of Byblos and Amuq points in the western part of the J13 structure might suggest a Later

Late Neolithic phase of occupation. The Transverse arrowheads in the upper part of the stratigraphy in the eastern part of the structure, in association with Nizzanim points and Byblos and a few Amuq and Herziliya points, might also suggest a Later Late Neolithic phase. However, if our Jilat blades were variants of Canaanean blades it is possible that the Transverse arrowheads might be associated with them in an Early Bronze Age assemblage with many Late Neolithic residuals.

It is clearly apposite to discuss the C14 dates from the site. One date derives from a sample from the earliest deposits on bedrock. OxA-1800 (A21a) produced a date of 5,970 ± 100 b.c. clearly suggesting, along with the point assemblage (with its strong component of PPNB point types), that this is an Early Late Neolithic assemblage. From the set of deposits overlying these, upper Phase I, came a date on a sample OxA-1801 (A15a) of 5,920 ± 100 also indicating that, despite the lower numbers of Amuq and Byblos points, this phase of occupation of the site should be assigned to the Early Late Neolithic. OxA-2411 5,950 ± 80 b.c. and UB-3462 5,879 ± 89 b.c. come from contexts late in the complex stratigraphic sequence on the site. They are both from *in situ* hearth fills (C24 and C22, in that order) and should not therefore be residual or intrusive. This can be stated with more than usual confidence because these hearths were constructed of stone slab uprights set in cuts, or deliberately created cavities, in the substantial stone paving in the eastern part of Structure **1**. This substantial limestone slab paving actually covered most of this area of the Structure (excavated as Area C) and completely sealed most of the contexts in which the Transverse arrowheads and Jilat blades were recovered (some also came from deposits resting on the paving). Contextual control was relatively tight because these contexts under the paving were excavated in artificially circumscribed, horizontally divided 'spatial units'. Thus particularly for shallowly stratified steppe and desert sites these diagnostic types are unusually well stratified and contexted, and unlikely to be intrusive. Similarly the actual samples of carbonized wood are unusually well contexted and secure and unlikely to be residual or intrusive. Further some control has been provided by dating these two completely separate samples, belonging to the same phase of activity, in separate laboratories and by separate techniques, the Oxford accelerator and University of Belfast. The results confirm each other and suggest a relatively (and perhaps uncomfortably) high degree of accuracy for the dates. These two closely comparable dates provide a *terminus ante quem* for the Jilat blades and Transverse arrowheads. It seems that we have to take the association of the Jilat blades and Transverse arrowheads with an assemblage also characteristic of the earlier part of the J13 sequence as genuine. The date of this assemblage falls in the first half of the 6th M.b.c. as with earlier occupations on the site. It is therefore an Early Late Neolithic. Because the Haparsah points occur in the upper part of the sequence in the western end of Structure 1 we cannot necessarily associate them with the Early Late Neolithic occupation and so a Later Late Neolithic might also be present in this Area (Area A).

The implications of this evidence from J13 are far reaching. It indicates that the earliest Late Neolithic does indeed have point assemblages with significant proportions of Amuq and Byblos points. On the other hand assemblages with high proportions of Nizzanim and some Herziliya points seem to arise relatively rapidly and it suggests that Transverse arrowheads join other Late Neolithic point types within the first half of the 6th M.b.c. In short it may well be worthwhile to distinguish an Early Late Neolithic, but the evidence may suggest that it occupies in a distinct form in terms of chipped stone assemblages, at least, only a short period of time at the beginning of the 6th M.b.c. It seems likely that Transverse arrowheads and Haparsah points did not become common components of assemblages until the second half of the 6th M.b.c. However, assemblages that have Transverse arrowheads (and possibly Haparsah points), at least in small proportions, may equally well belong to the first as the second half of the 6th M.b.c., in the absence of other indicators. J13 does provide a clear seriation of assemblages in the transitional phase from PPNB to Late Neolithic. Early assemblages have high proportions of PPNB types with some Nizzanim and Herziliya types; Nizzanim and Herziliya types come to dominate; only after this do Transverse arrowheads and (or possibly later) Haparsah points appear.

Section 4.4.6. Wadi el-Jilat 25.

On the site of J25 only one trench was excavated (figs. 4.23 and 4.24). This encompassed the northern third of a large oval structure and the immediately adjacent external areas. 2 major phases of deposition were documented, the second did not relate to occupation of that particular structure. Each major phase encapsulates a sequence of episodes. The first phase represents continuous use/reuse of the structure. In this first phase a sequence of ashy occupation deposits grade into each other and are demarcated only by the construction of fixtures which may be hearths, bins or structural supports (fig. 4.24). The second phase is marked by an accumulation of a mass of rubble, probably dump, but it may include structural debris (contexts analyzed J25A2b and J25A6b). In and over this rubble wind blown silts accumulated. The point assemblage throughout this depositional sequence was the same; it was completely dominated by Nizzanim points (table 4.1). The absence of Haparsah points and Transverse arrowheads is suggestive of an Early Late Neolithic period of occupation, but not conclusive. OxA-2408 from a fill low in the depositional sequence produced a date of 6,070 ± 80 b.c. confirming an Early Late Neolithic period for the occupation(s).

The chronological relationship of J25 and J13 is therefore of some interest. The PPNB/Late Neolithic transitional nature of the earliest point assemblage from J13 is not matched on J25. It is tempting, on this basis, to suggest that the J25 occupation post-dates that of J13 Phase I. The presence of Transverse arrowheads and Haparsah points more common on later Late Neolithic sites might lend one to suggest that J13 Phase II post-dates the J25 occupation. Given the sample sizes involved (table 4.1) it is perhaps prudent to reserve judgement on this issue.

Table 4.1: Numbers of each point type on each phase of Azraq project Neolithic sites.

Occupation	J7I	J7II	J7III	J32	J26	A31I	J13I	J13II	J25	A31II	A31M
Salibiya	1										
Jordan valley	1										
Khiam	7	4	2								
Helwan	28	9	14								
Jericho	1	2	1								
Byblos	1	8	15	2	20	19	9	17		12	7
Amuq					7		4	3		5	7
Nizzanim							14	19	13	2	8
Herziliya							5	5			9
Haparsah								2			
Transverse								**5**			
Hagduds	24	5									

The combined evidence of C14 dates and point assemblages from J13 and J25 suggests that high proportions of Byblos, and Amuq points with some or many Nizzanim points and the absence of Haparsah points and Transverse arrowheads indicates an Early Late Neolithic period, at least in steppe sites in the east of Jordan. The presence of **low** proportions of Transverse arrowheads does not imply that an assemblage with Nizzanim, Herziliya, Amuq and Byblos points is Later Late Neolithic.

Table 4.2. Tabulation of sites by period for south Levant with some key north Levantine sites.

This table occupies the following two pages. Abbreviations in brackets after site names are used in the table to indicate the more precise location of arid zone sites. They are:
EJR = East Jordanian Reg.
EJH = East Jordanian Harra.
WA = Wadi Arabah (including immediately adjacent areas like the Hisma).
N = Negev.
S = Sinai.

Period	N. Levant moist	N. Levant arid	S. Levant moist	S. Levant arid
8,300-7,500	**PPNA-Early PPNB**		**PPNA**	
	Mureybet II-III Nacharini (Schroeder n.d.) Aswad Ia		Nahel Oren Gesher Gilgal Salibiya IX Netiv Hagdud Hatoula Iraq ed Dhub El Khiam Dhra	Nahal Lavan 108(N) Poleg M18(N) Abu Salem(N) Abu Maadi(S)
7,500-7,200/7000	**Middle PPNB**		**Early PPNB**	
	Mureybet IV Aswad Ib		Mujahiya Sabra Ic	Wadi Jilat 7(EJR) Wadi Jilat 13(EJR) Jebel Queisa 24(WA) Nahal Lavan 109(N)
7,500-6,500			**Early/Middle PPNB**	
			Nahal Oren Sefunim Abou Gosh Ad Daman	Uweinid 6 (EJR) Wadi Jilat 32(EJR) Michmoret 26(N) Nahal Boqer(N) Abu Salem(N)
7,200/7,000-6,500	**Middle PPNB**		**Middle PPNB**	
	Mureybet IVb? Ghoraife I Aswad II Abu Hureyra		Yiftahel Munhata Abou Gosh Ain Ghazal Jericho Beidha VI-V	Wadi Jilat 7(EJR) Wadi Jilat 26(EJR) Nahal Hemar(N) Ain Qadeis(S) Jebel Rubsha(S)
7,200/7,000-6,000	**Middle/Late PPNB**		**Middle/Late PPNB**	
			Kharaysin Beidha III-I Shaqarat Msiad	Wadi Jilat 7(EJR) Wadi Jilat 32(EJR) Nahal Divshon(N) Nizzana(N) Nahal Reu'el(N) Mushabi VIH(S) Ramat Matred VVI(S) Abu Maadi III lower(S)

6,500-6,000	**Late PPNB**		**Late PPNB**	
	Ras Shamra Vc	Bouqras	Atlit	Burqu 35(EJH)
	Ramad III	Tell es Sinn	Beisamoun	Dhuweila I(EJH)
	Ghoraife II		Tell Eli	Azraq 31(EJR)
	Abu Hureyra		Ain Ghazal	Mesad Mesal(WA)
			Basta	Nahal Issaron(WA)
			Baga	Nahal Hemar(N)
				Gebel Gunna(S)
				Wadi Jibba I(S)
				Ujrat el Mehed(S)
				Wadi Tbeik(S)
				Abu Maadi III-upper(S)
			Late PPNB/Early Late Neolithic	
				Ibn el-Ghazzi(EJH)
				A A Nekeileh(WA)
				Wadi Ahmar 509(S)
				Umm el-Muqur(WA)
6,000-5,600	**Final PPNB**		**PPNC/Early Late Neolithic**	
	Abu Hureyra	El Kowm I	Tell Eli	Azraq 31(EJR)
	Ras Shamra Vb	El Kowm II	Shaar ha Golan	
	Ramad II	Qdeir I	Ain Ghazal	Wadi Jilat 13(EJR)
	Labwe I	Bouqras	Basta	Wadi Jilat 25(EJR)
				Qadesh Barnea 3(S)
5,600-4,500	Amuq A/B		**Later Late Neolithic (PNA/early PNB)**	
	Ras Shamra Va	Bouqras	Tell Eli	Jebel Naja(EJH)
	Byblos Neo Ancien		Munhata	Burqu 27(EJH)
	Labwe II-III		Ain Rahub	Dhuweila II(EJH)
	Ramad I		Abu Thawwab	Burqu 3(EJH)
			Ain Ghazal	Ghirqa 2331(EJH)
			Jericho	Ghirqa 2229(EJH)
				Ghirqa 2332(EJH)
			Haparsah	Nahal Issaron(WA)
			Batashi	Nahal Sekher 81a(N)
			Nizzanim	
			Qatif Y3	
6,000-4,500			Earlier and Later Late Neolithic	
			Beisamoun	Wadi Jibba II(a)(S)
			Abou Gosh	
			Herziliya	Qadesh Barnea 31(S)
			Dhra	Wadi Jilat 23(EJR)
				Wadi Jilat 24(EJR)
			Zikim	
			Ashkelon	

Table 4.3 C14 dates from arid zone Neolithic sites

Site	Date b.c.	SD1sigm	High2s	Low2s	Lab No.	Context
Abu Maadi	8160	100	8360	7960	PTA2699	
Abu Salem	8280	150	8580	7980	I5499	
Abu Salem	8020	150	8320	7720	I5498	
Divshon	6950	180	7310	6590	SMU3	
Divshon	6670	140	6910	6390	I5501	
Divshon	6220	180	6580	5860	Tx1123	
Wadi Jilat 7	6860	110	7080	6640	OxA526	J7 6.28a
Wadi Jilat 7	6570	110	6790	6350	OxA527	J7 8.25a
Wadi Jilat 7	6440	80	6600	6280	OxA2413	J7 A34a
Wadi Jilat 26	6790	110	7010	6570	OxA2969	J26 Ed18
Wadi Jilat 26	6770	100	6970	6570	OxA2407	J26 C12a
Wadi Jilat 26	6740	110	6960	6520	OxA1802	J26 Cb7a
Azraq 31	6400	120	6640	6160	OxA870	Az31 1.10
Azraq 31	6325	80	6485	6165	OxA2412	Az31 C19
Dhuweila 1	6400	100	6600	6200		
Dhuweila 1	6240	60	6360	6120	BM2349	
Mesad Mezal	6530	70	6670	6390	E2787	
Mesad Mezal	6490	80	6650	6330	Hv9108	
Mesad Mezal	6400	75	6550	6250	KN2444	
Mesad Mezal	6380	75	6530	6230	Hv9107	
Mesad Mezal	6290	95	6480	6100	Hv9106	
Mesad Mezal	6120	75	6270	5970	KN2443	
Issaron	6480	80	6640	6320	PTA3000	
Issaron	6230	80	6390	6070	PTA3377	
Issaron	6100	80	6260	5940	PTA3376	
Ujrat Mehed	6270	80	6430	6110	PTA2703	
Burqu 35	6320	80	6480	6160	OxA2770	112
Burqu 35	6230	80	6390	6070	OxA2769	208
Burqu 35	6190	90	6370	6010	OxA2768	207
Wadi Jilat 13	5970	100	6170	5770	OxA1800	J13 A21a
Wadi Jilat 13	5950	80	6110	5790	OxA2411	J13 C24
Wadi Jilat 13	5920	100	6120	5720	OxA1801	J13 A15a
Wadi Jilat 13	5879	89	6057	5701	UB3462	J13 C22
Wadi Jilat 25	6070	80	6230	5910	OxA2408	J25 Aa19
Burqu 27	5980	80	6140	5820	OxA2766	142
Burqu 27	5400	80	5560	5240	OxA2765	141
Burqu 27	5320	80	5480	5160	OxA2764	132
Jebel Naja	5480	100	5680	5280	OxA375	
Dhuweila 2	5500	90	5680	5320	OxA1729	
Dhuweila 2	5190	90	5370	5010	OxA1728	
Dhuweila 2	5080	90	5260	4900	OxA1636	
Burqu 03	4950	100	5150	4750	OxA2808	158

Table 4.4 C14 dates from Mureybet and Aswad

Site	Date b.c.	SD1sigma	High2s	Low2s	Lab No.	Context	Phase
Mureybet	8220	200	8420	8020	MC635	Q33B4ffXXV	Ia
Mureybet	8140	170	8480	7800	MC674	Q33B4ffXXV	Ia
Mureybet	8400	150	8700	8100	MC675	Q33B4ffXXXII	Ia
Mureybet	8280	170	8620	7940	MC731	Q33B4z1	Ia
Mureybet	8280	170	8620	7940	MC732	Q32EIc	Ia
Mureybet	8080	150	8380	7780	MC733	R34BIaz1-2	Ia
Mureybet	8640	140	8920	8360	Lv607	P32B4	Ib
Mureybet	8640	170	8980	8300	Lv605	Q32A2ffX	II
Mureybet	8510	200	8910	8110	Lv606	Q32C1BffII	II
Mureybet	8056	96	8248	7964	P1215	I	II
Mureybet	8142	118	8378	7906	P1216	I base	II
Mureybet	8265	117	8499	8031	P1217	II	II
Mureybet	7780	140	8060	7500	Lv604	Q32ffIII	III
Mureybet	7890	200	8290	7490	MC611	S32A2z2	III
Mureybet	7570	150	7870	7270	MC612	S32A2z4	III
Mureybet	7670	200	8070	7270	MC613	S32A2cHXIV	III
Mureybet	7620	200	8020	7220	MC614	S32ffXVI	III
Mureybet	7590	110	7810	7370	MC615	S32C1x3	III
Mureybet	7725	110	7945	7505	MC616	R32A1HXXII	III
Mureybet	8000	150	8300	7700	MC734	R32w2StXLVII	III
Mureybet	7780	150	8080	7480	MC735	R31HXXII	III
Mureybet	8018	115	8248	7788	P1220	X-XI	III
Mureybet	7954	114	8182	7726	P1222	XVI	III
Mureybet	7542	122	7786	7298	P1224	XVI	III
Mureybet	7650	150	7950	7350	MC861	AD34 -8.45m	IVa
Mureybet	7180	150	7480	6880	MC862	AD34 -8.90m	IVa
Mureybet	7080	150	7380	6780	MC863	AD34 -9.20m	IVa
Mureybet	7330	150	7630	7030	MC736	AD28nXIV	IVb
Mureybet	6960	150	7260	6660	MC737	AD28nXV	IVb
Aswad	7690	120	7930	7450	Gif2372		I
Aswad	7790	120	8030	7540	Gif2633		I
Aswad	7390	120	7630	7150	Gif2370		I
Aswad	7320	120	7560	7080	Gif2371		I
Aswad	6925	55	7035	6815	GrN6678		I
Aswad	6915	60	7035	6795	GrN6679		I
Aswad	6590	110	6810	6370	Gif2369		II
Aswad	6610	110	6830	6390	Gif2373		II
Aswad	6700	55	6810	6590	GrN6676		II
Aswad	6770	75	6920	6620	GrN6677		II

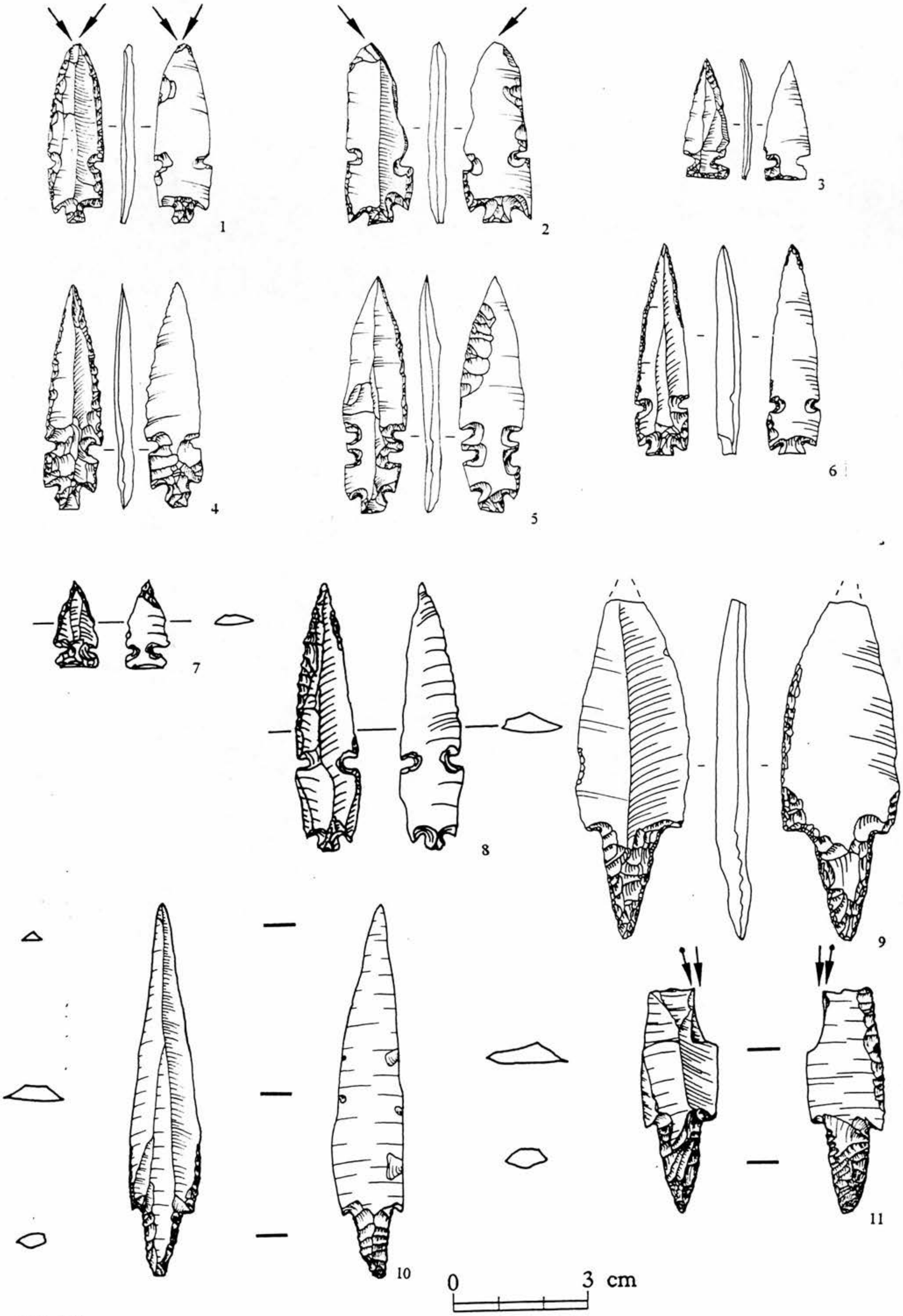


Fig. 4.1

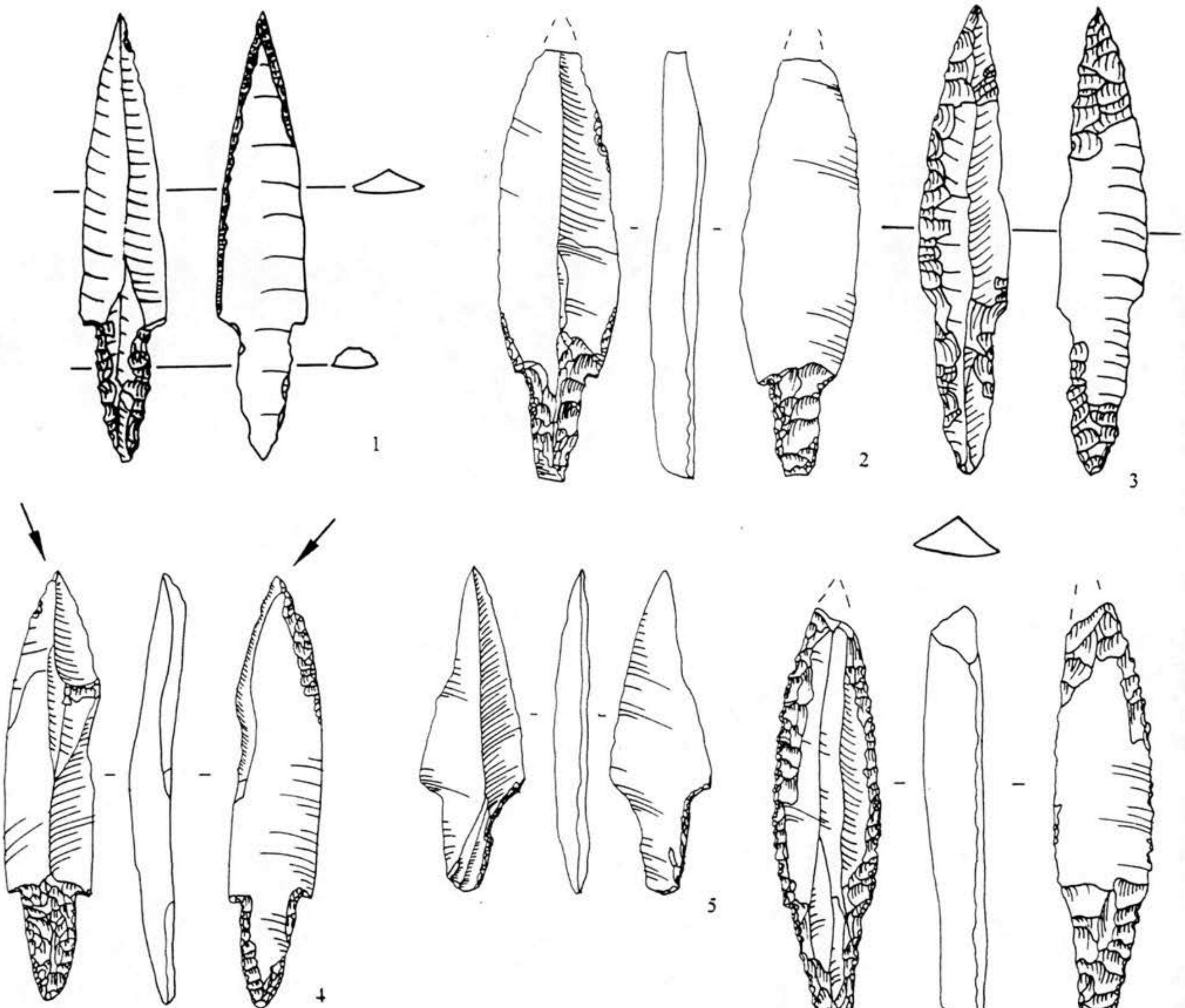


Fig 4.2

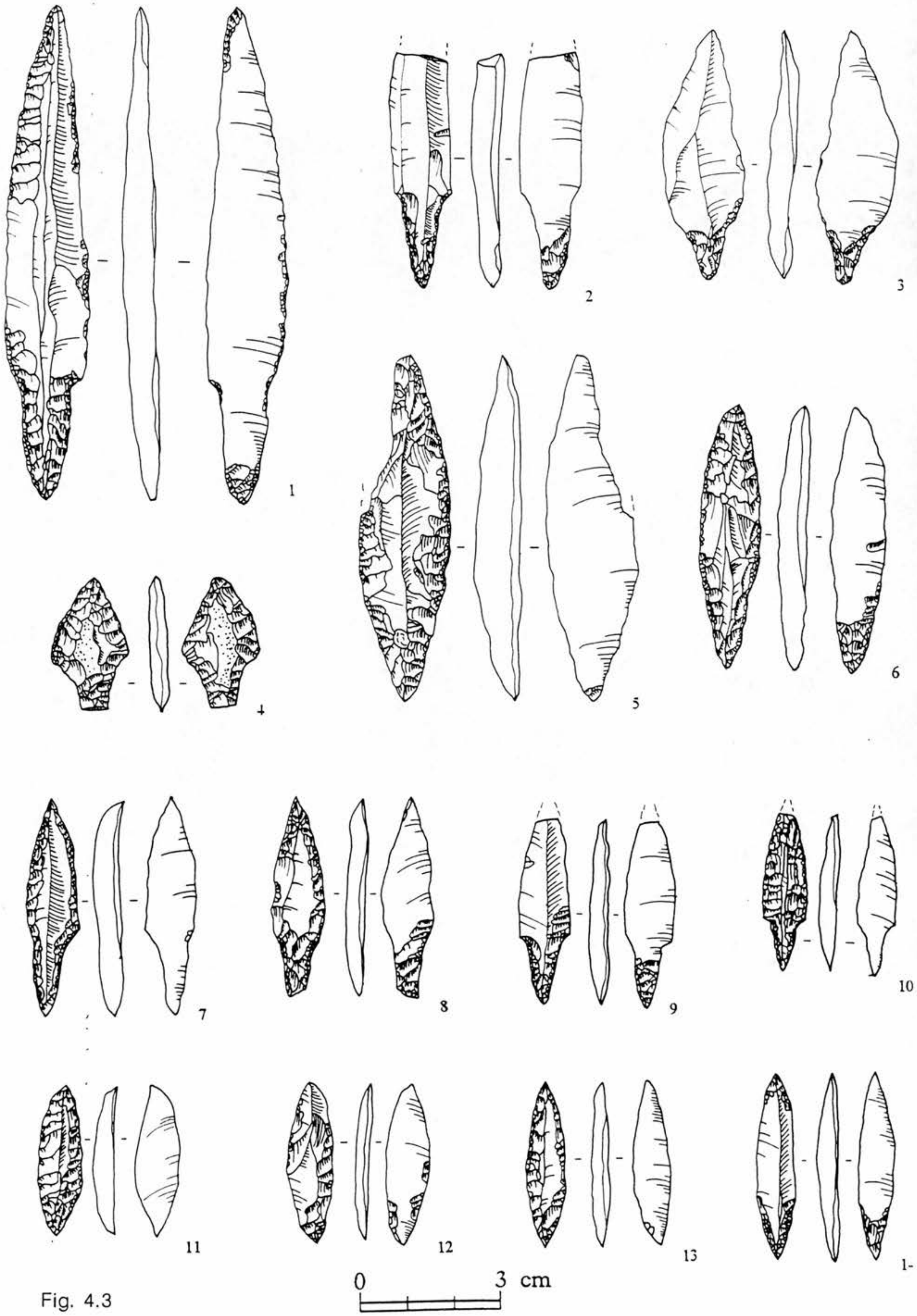


Fig. 4.3

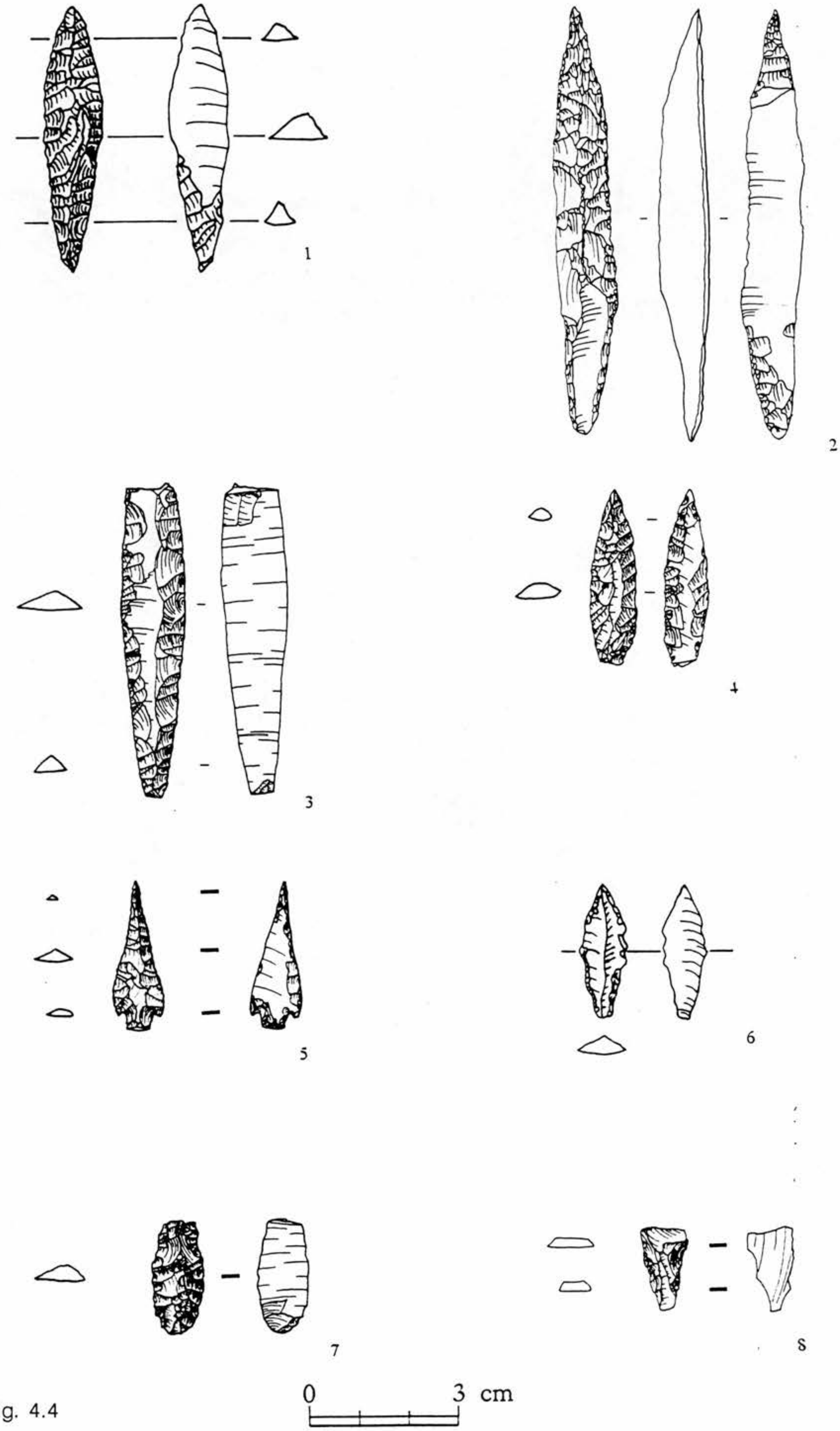


Fig. 4.4

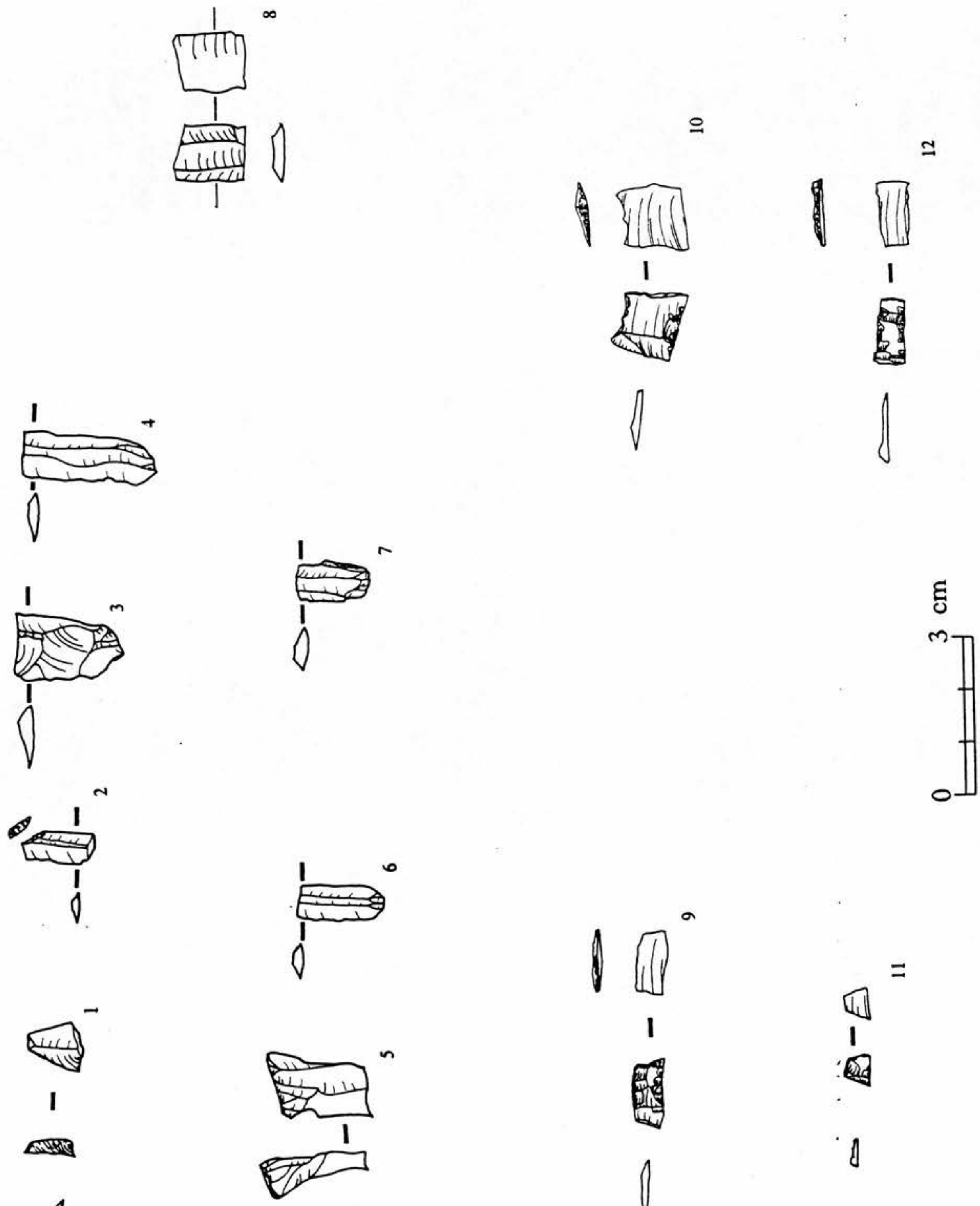


Fig. 4.5

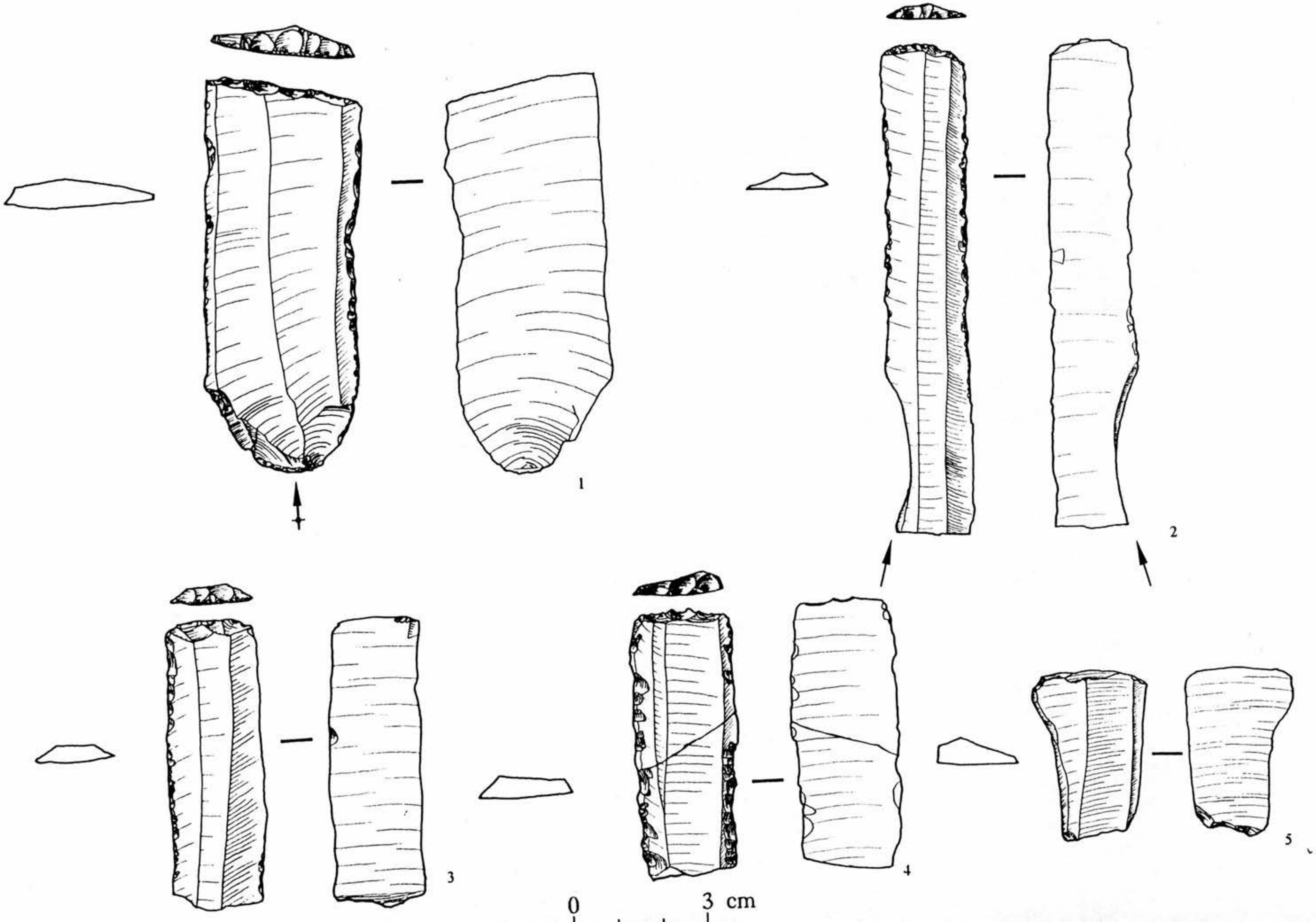


Fig. 4.6

Fig. 4.7 C14 dates from arid zone Neolithic sites

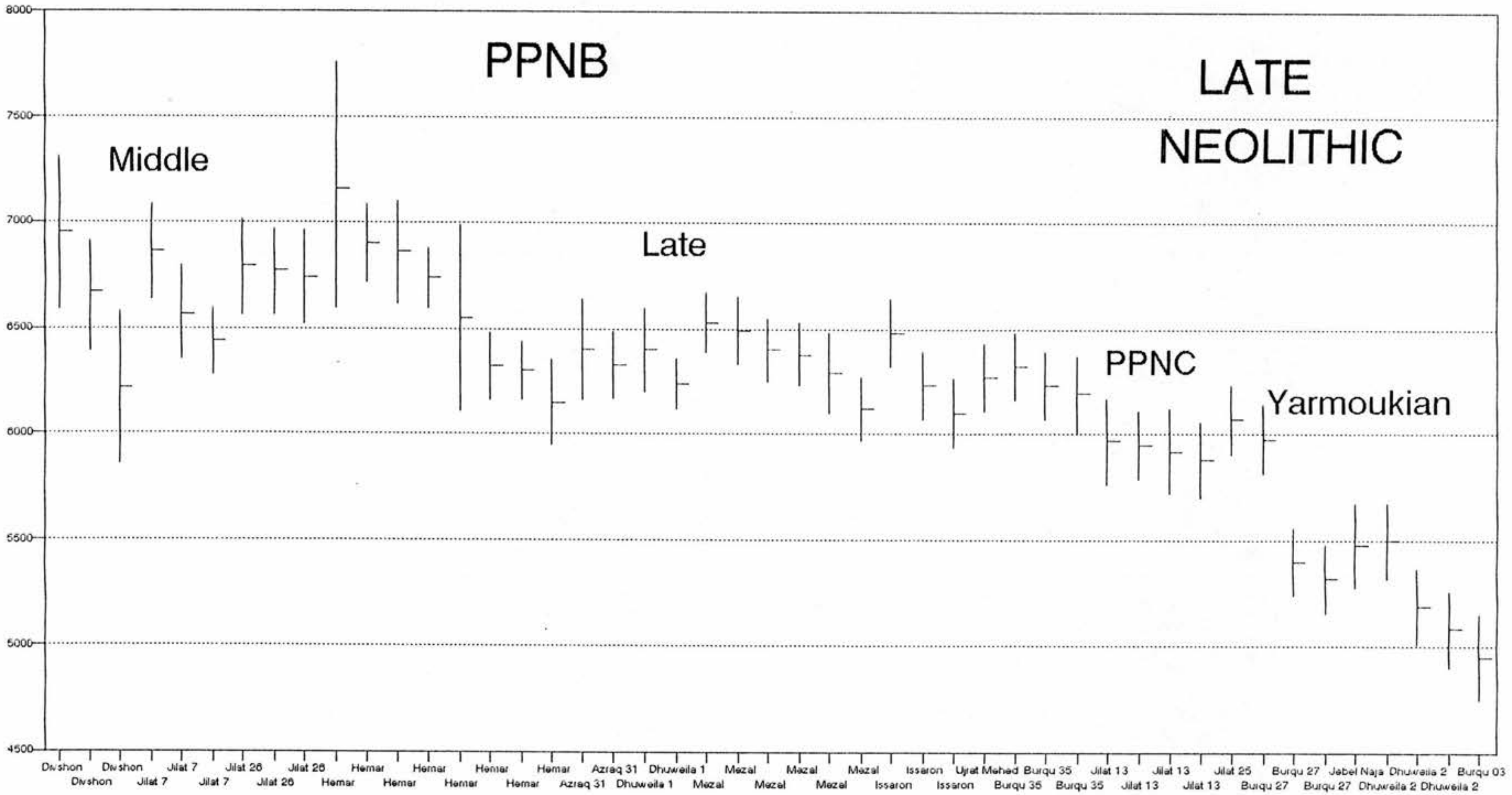


Fig. 4.8 C14 dates from Mureybet and Tell Aswad

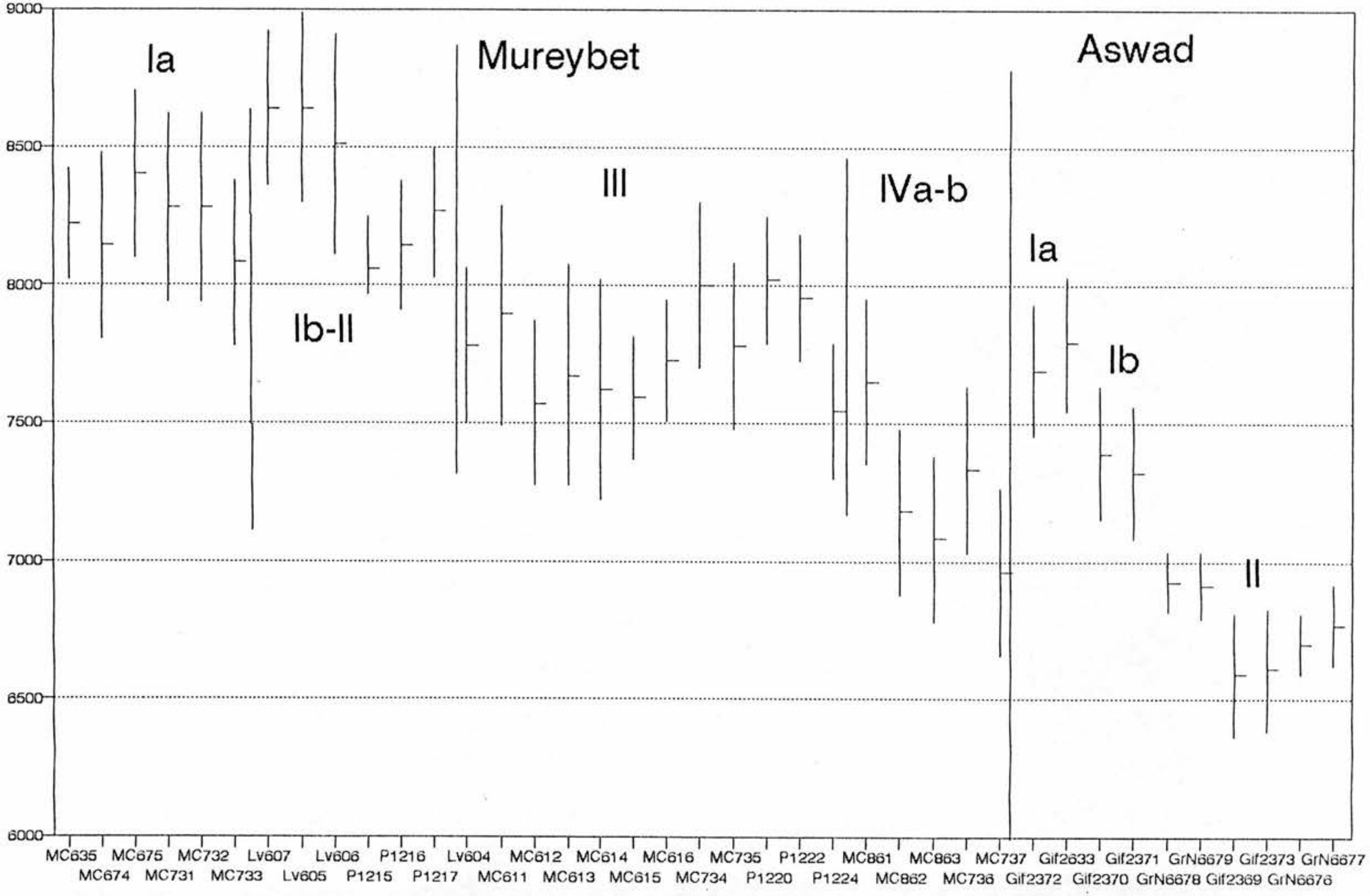


Fig. 4.9

J13 Phase I
PHASES ETC

□	Uncertain
▦	Early
▒	Early paving
▥	Early & Middle
▤	Middle
◌	Early hearth/pit
◌	Middle "
◌	Robbed
⊙	Upright slab

J13 Phase II
PHASES ETC

□	See previous figure
▨	Late
░	Late paving
◌	Late hearth/pit
◌	Robbed
⊙	Upright slab

J7, J25, J26
PHASES ETC

░	Early
▨	Middle (at two-phase WJ7B & WJ26A = Late)
▥	Late
□	Unknown
⊙	Upright slab
●	Bedrock mortar or stakehole
-.-.	Limit of area excavated to bedrock
PE	Only partially excavated
⌃	Bedrock cut
◌	Hearth
◠	Pit
◠	Robbed

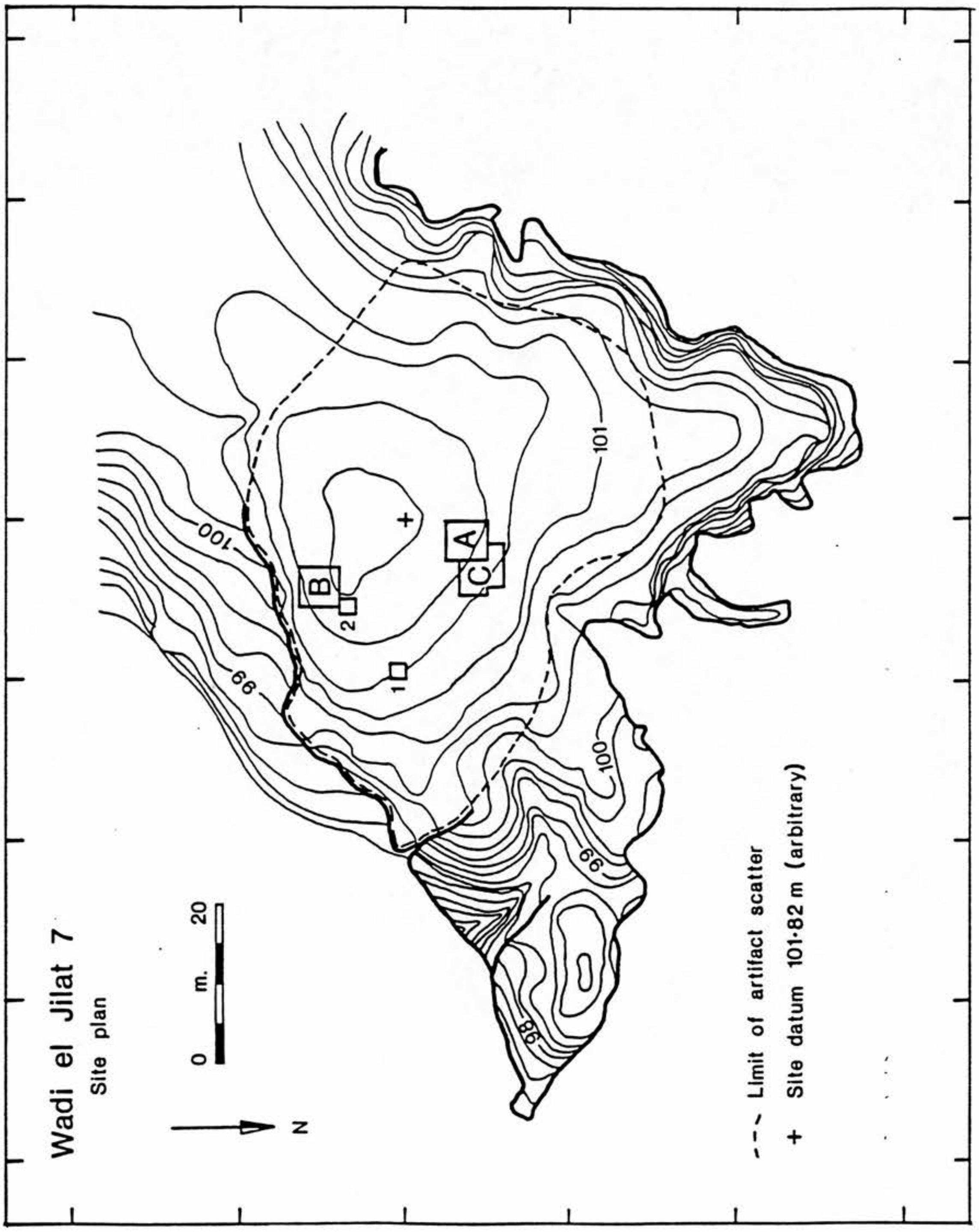

Wadi el Jilat 7
Site plan
0
m.
20
N
100
99
101
A
B
C
1
2
+
100
99
98
Limit of artifact scatter
+ Site datum 101·82 m (arbitrary)

Fig. 4.10

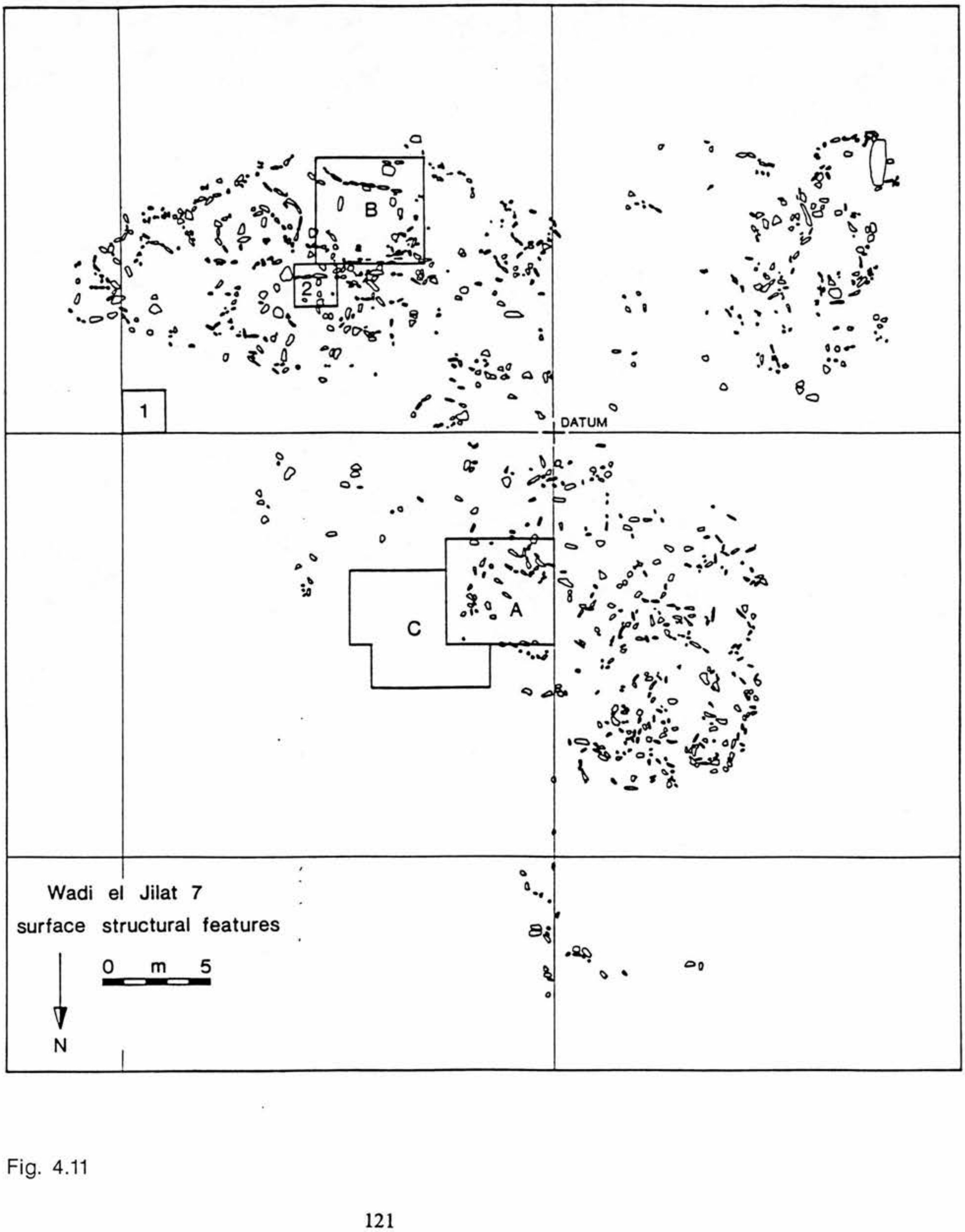

B
2
1
DATUM
A
C
Wadi el Jilat 7
surface structural features
0 m 5
N

Fig. 4.11

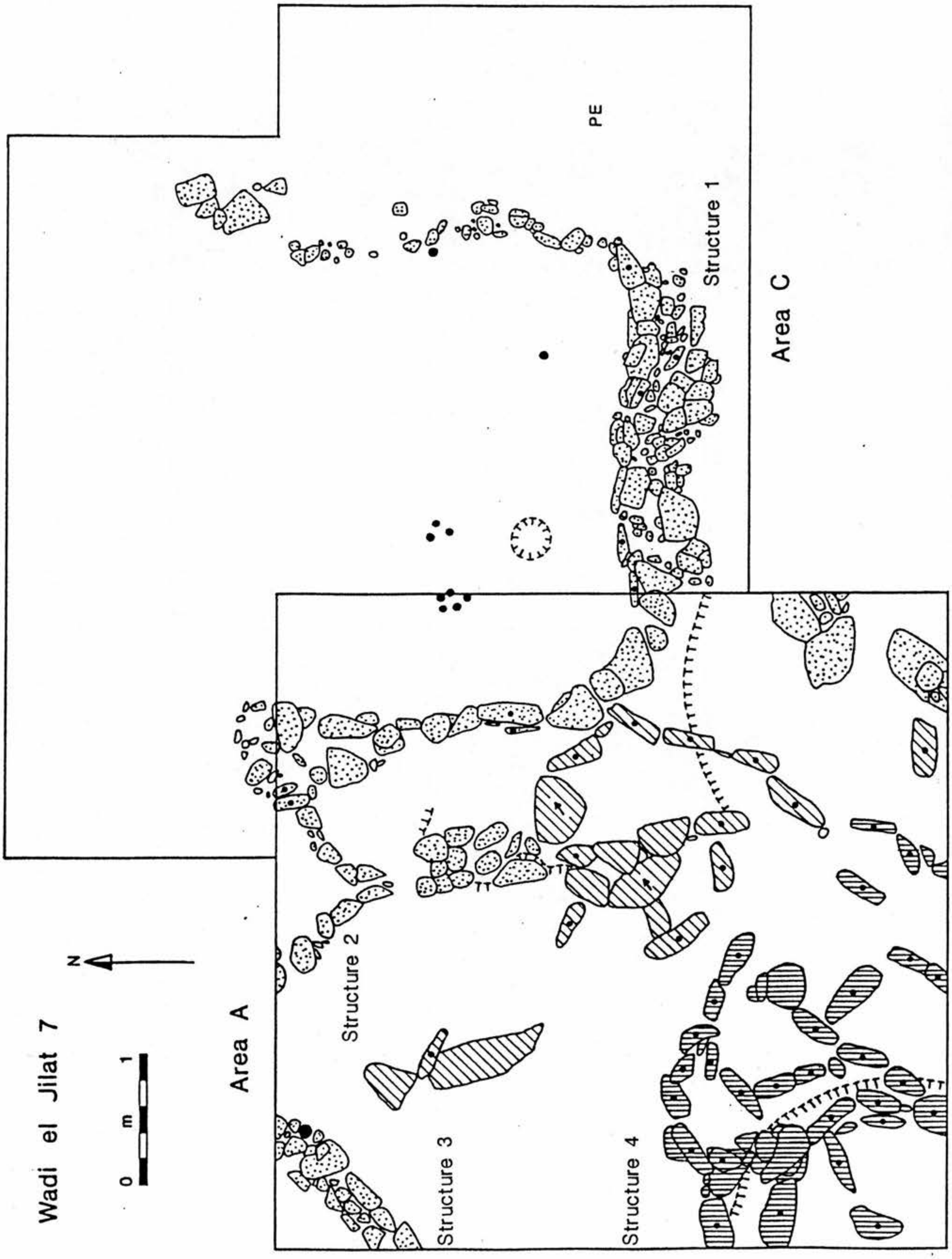

Wadi el Jilat 7
N
0 m 1
Area A
Area C
PE
Structure 1
Structure 2
Structure 3
Structure 4

Fig. 4.12

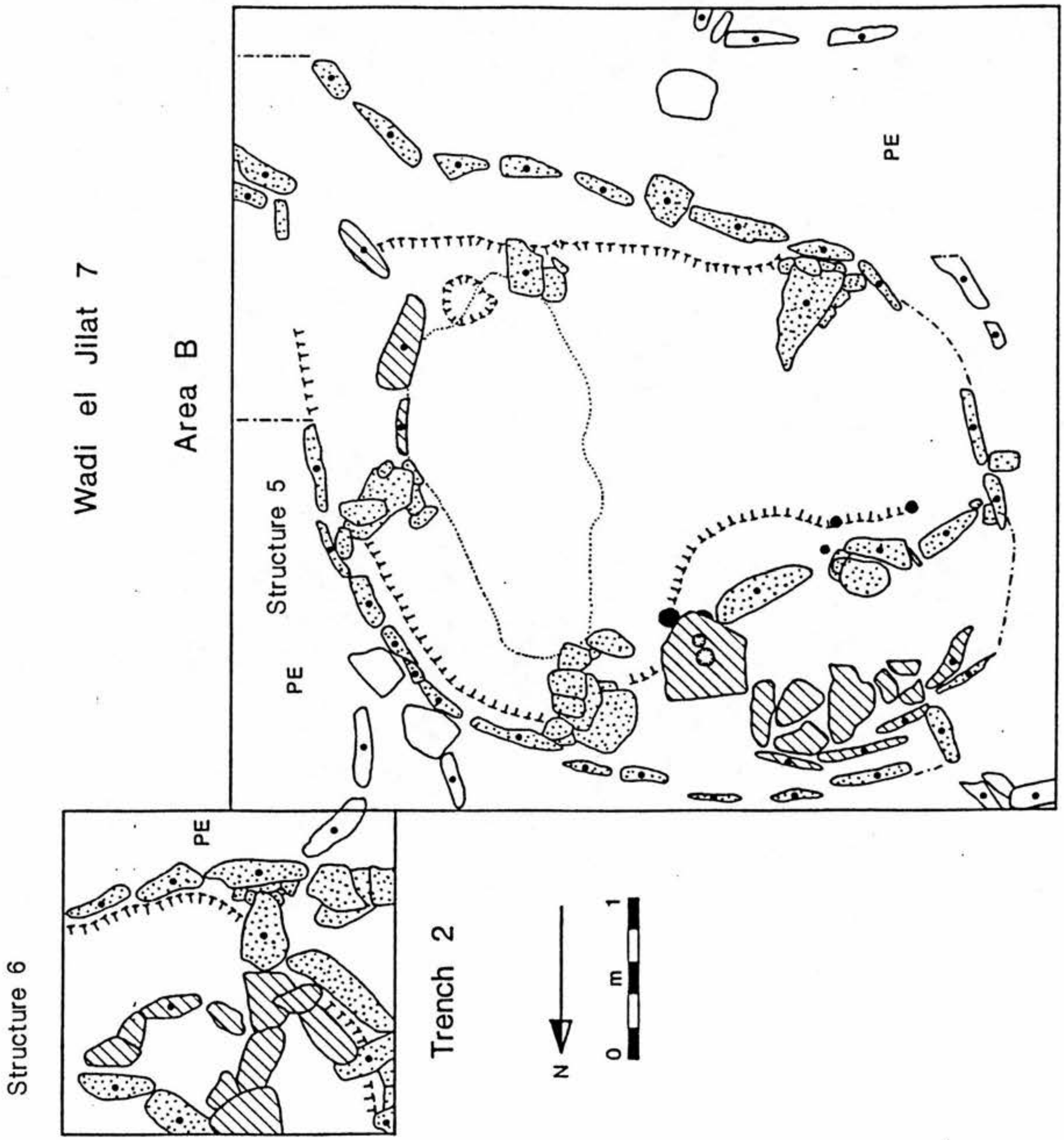

Wadi el Jilat 7
Area B
Structure 5
PE
PE
Structure 6
PE
Trench 2
N
0
m
1

Fig. 4.13

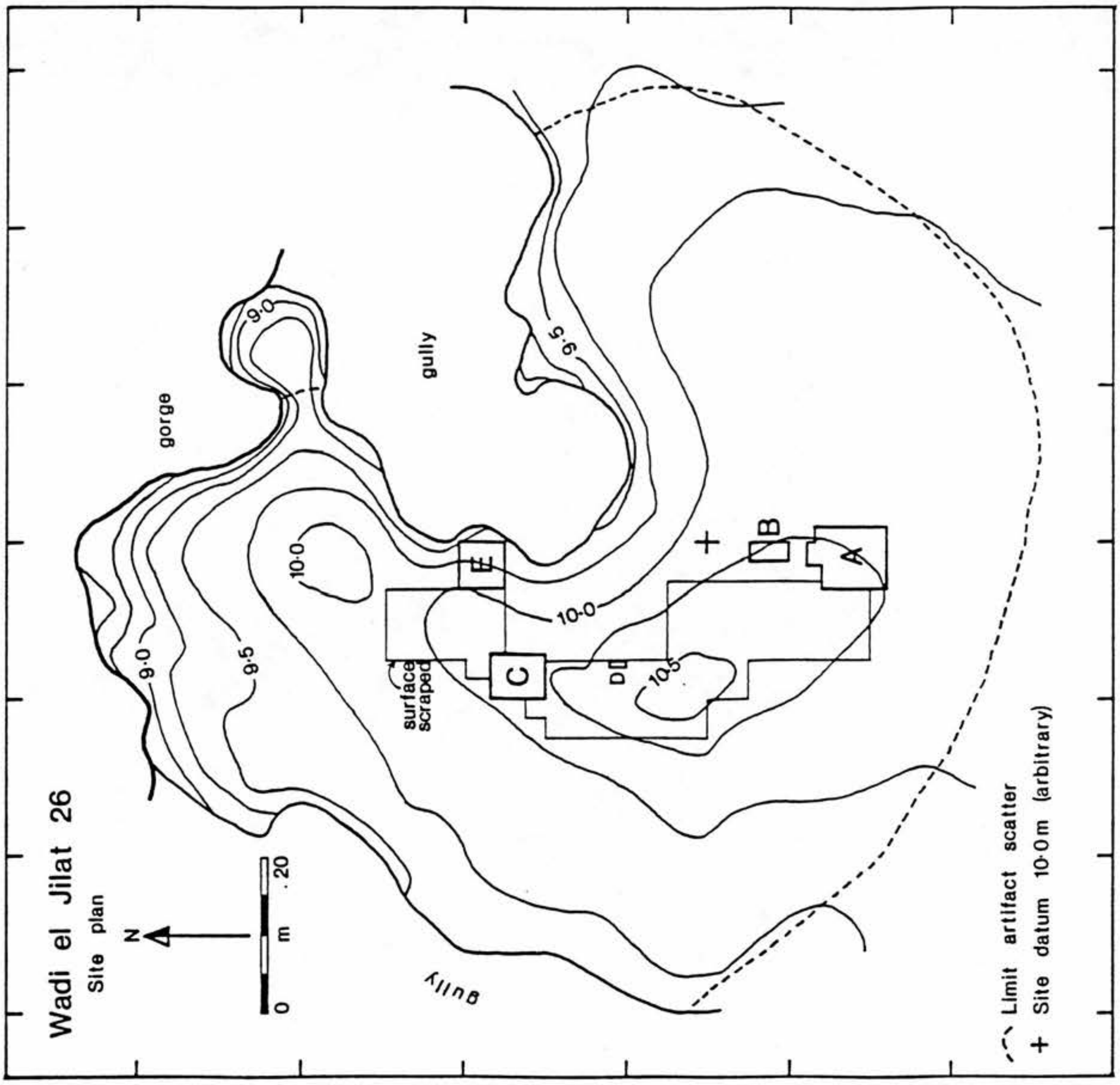

Wadi el Jilat 26
Site plan
N
0
m
20
gorge
gully
gully
9·0
9·0
9·5
9·5
10·0
10·0
10·5
surface scraped
A
B
C
D
E
Limit artifact scatter
+ Site datum 10·0 m (arbitrary)

Fig. 4.14

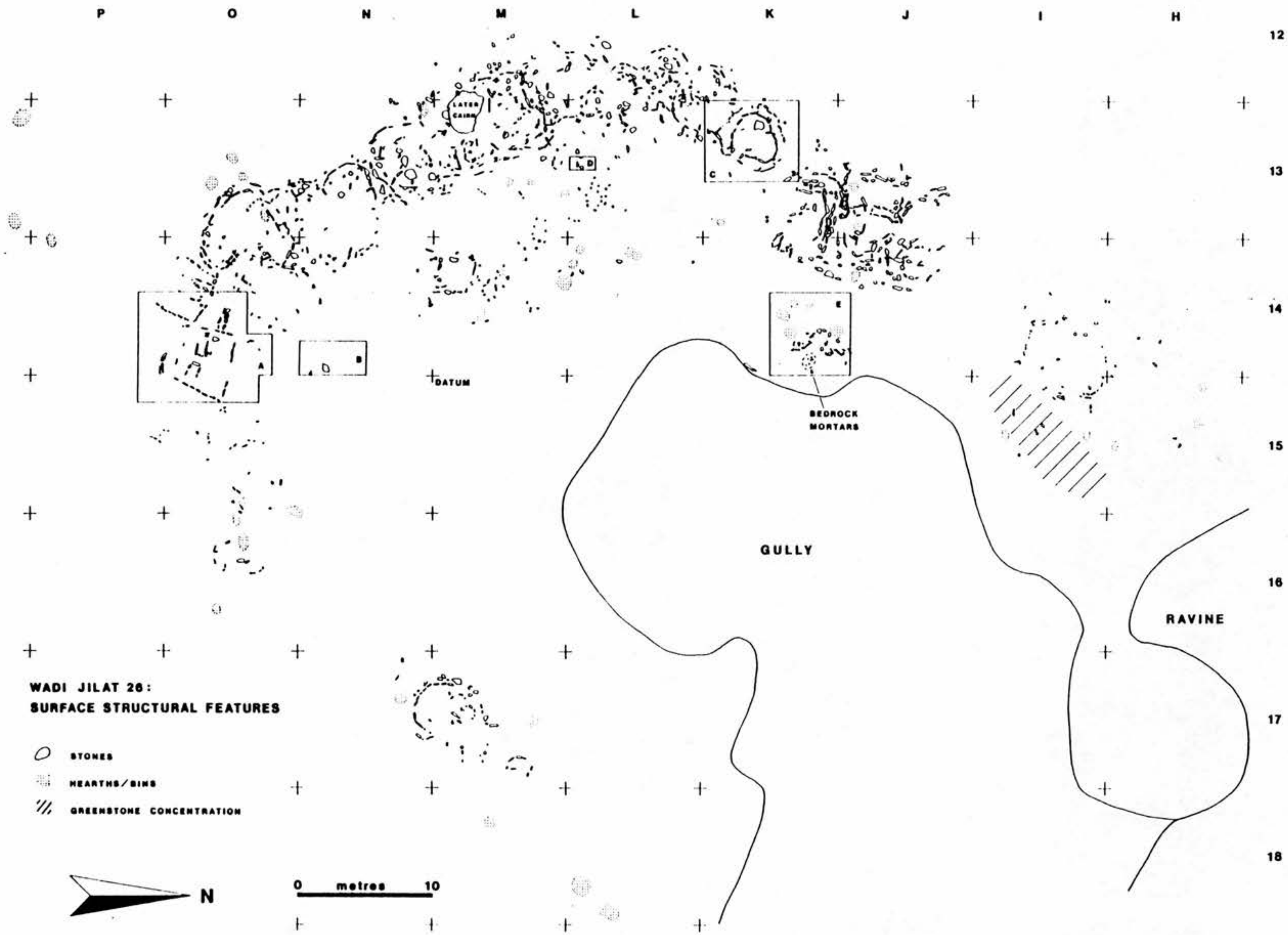

P
O
N
M
L
K
J
I
H
12
13
14
15
16
17
18
LATER CAIRN
A
B
C
D
E
DATUM
BEDROCK MORTARS
GULLY
RAVINE
WADI JILAT 26:
SURFACE STRUCTURAL FEATURES
STONES
HEARTHS/BINS
GREENSTONE CONCENTRATION
N
0 metres 10

Fig. 4.15

Wadi el Jilat 26 Area A

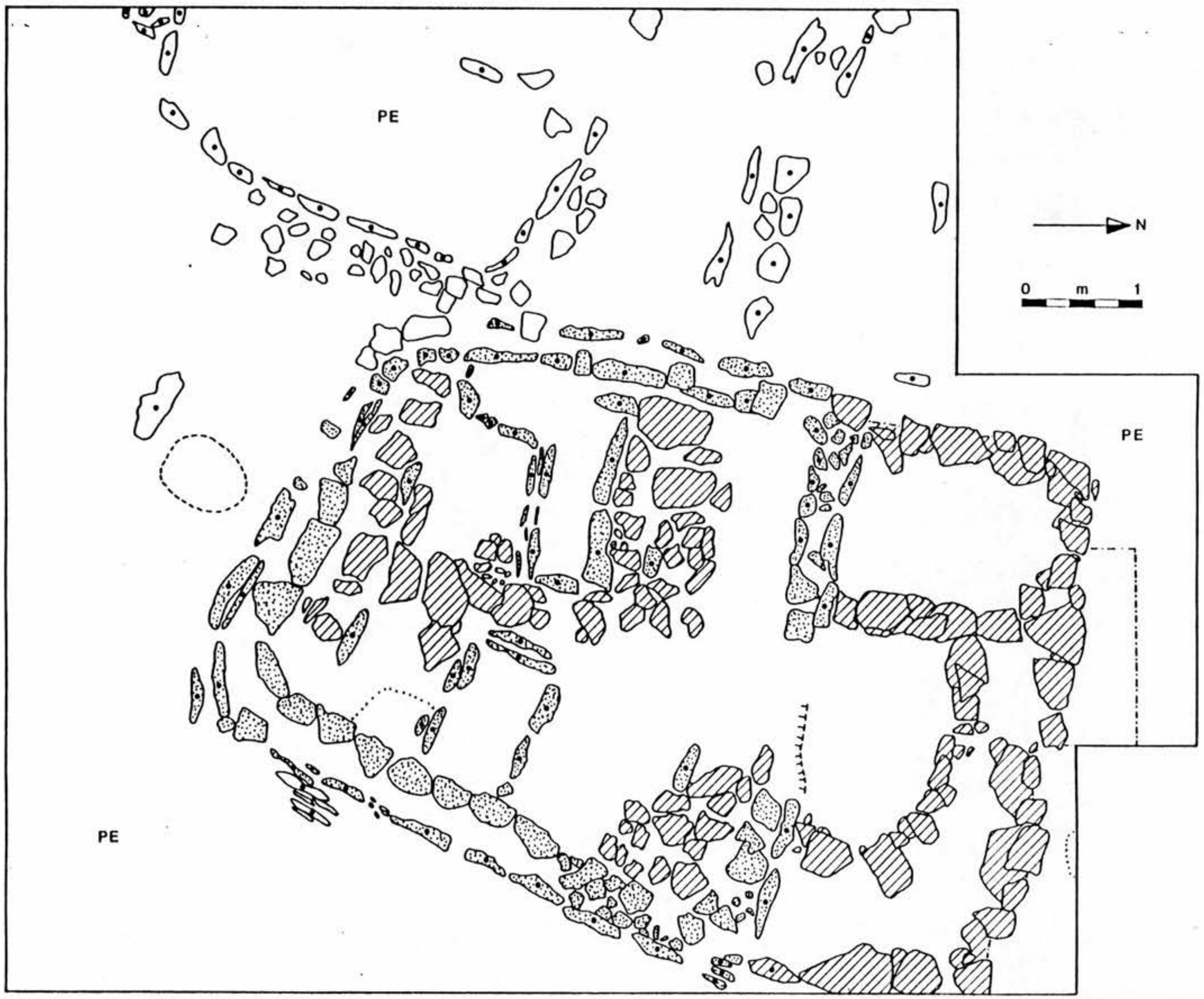


Fig.4.16

Wadi el Jilat 26 Area C

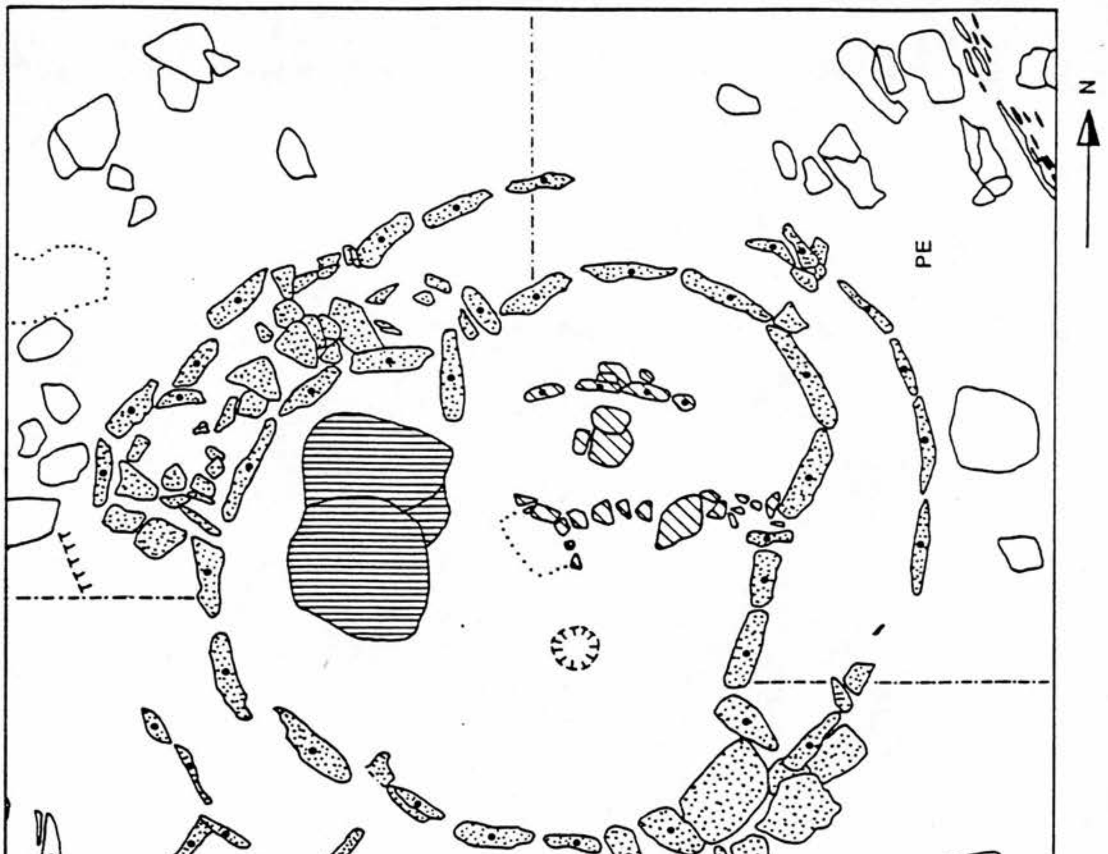


Fig. 4.17

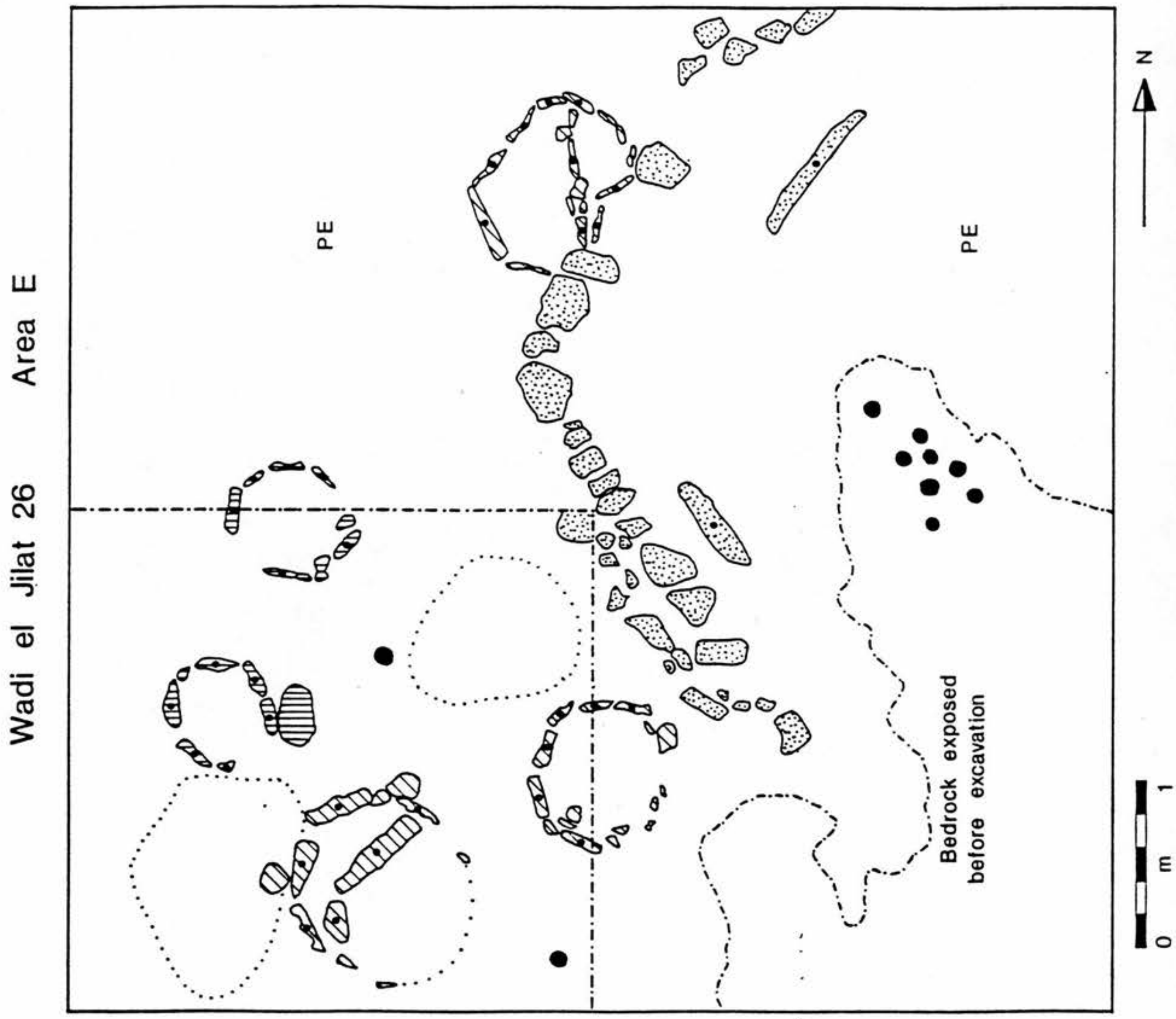

Wadi el Jilat 26 Area E
PE
PE
N
Bedrock exposed before excavation
0 m 1

Fig. 4.18

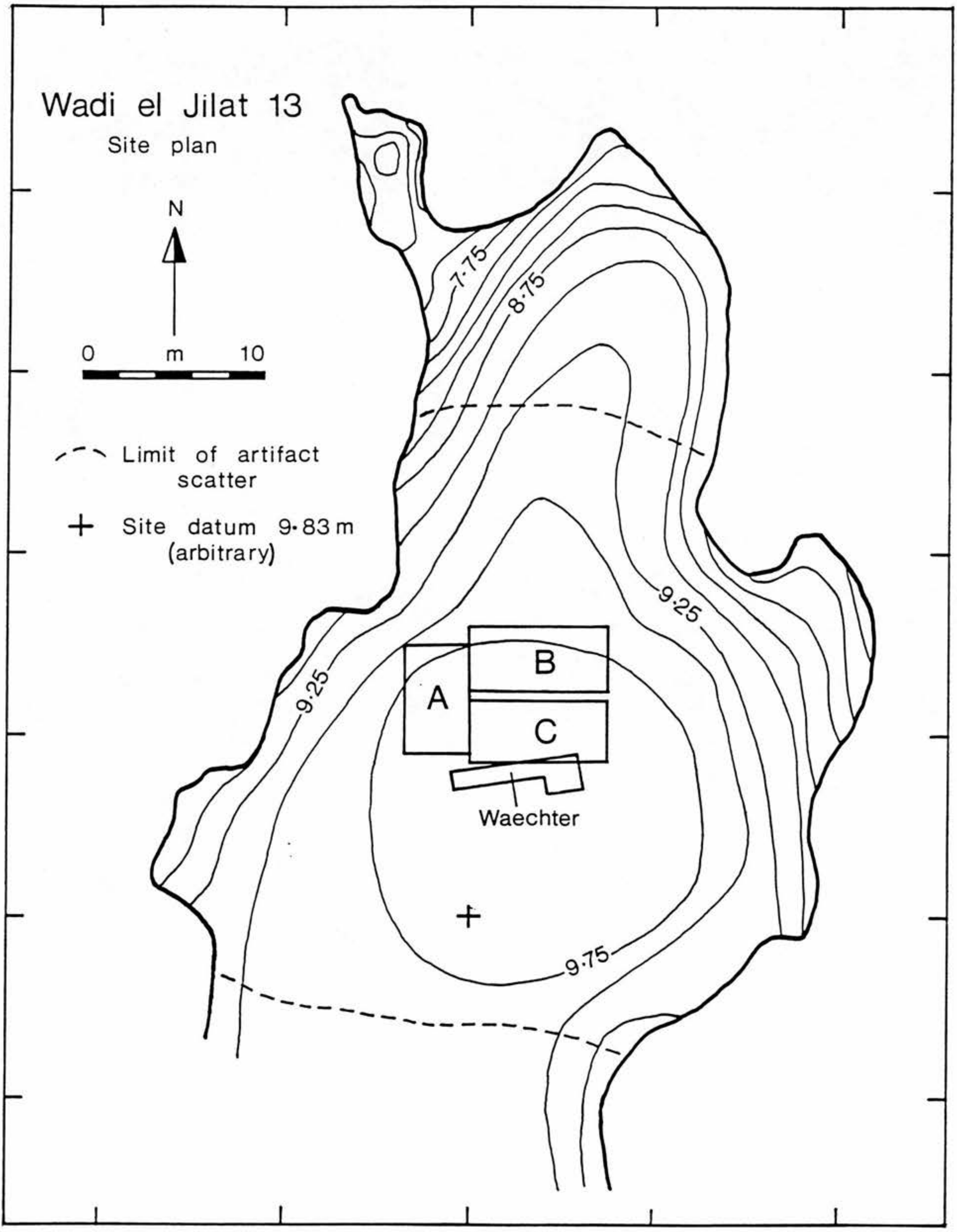

Wadi el Jilat 13
Site plan
N
0
m
10
Limit of artifact scatter
+ Site datum 9·83 m (arbitrary)
7·75
8·75
9·25
9·25
9·75
A
B
C
Waechter

Fig.4.19

Wadi el Jilat 13
Bedrock features

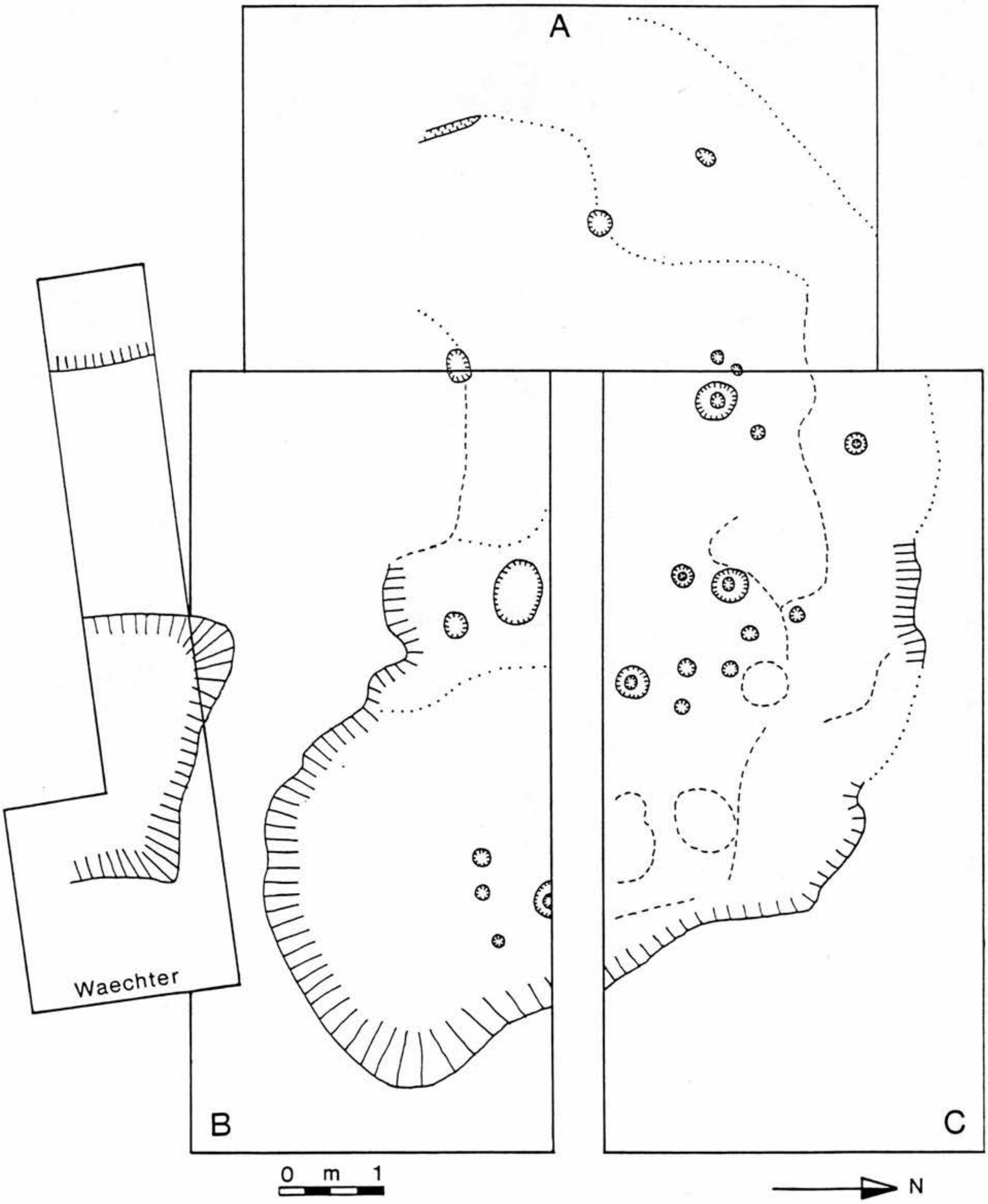


Fig.4.20

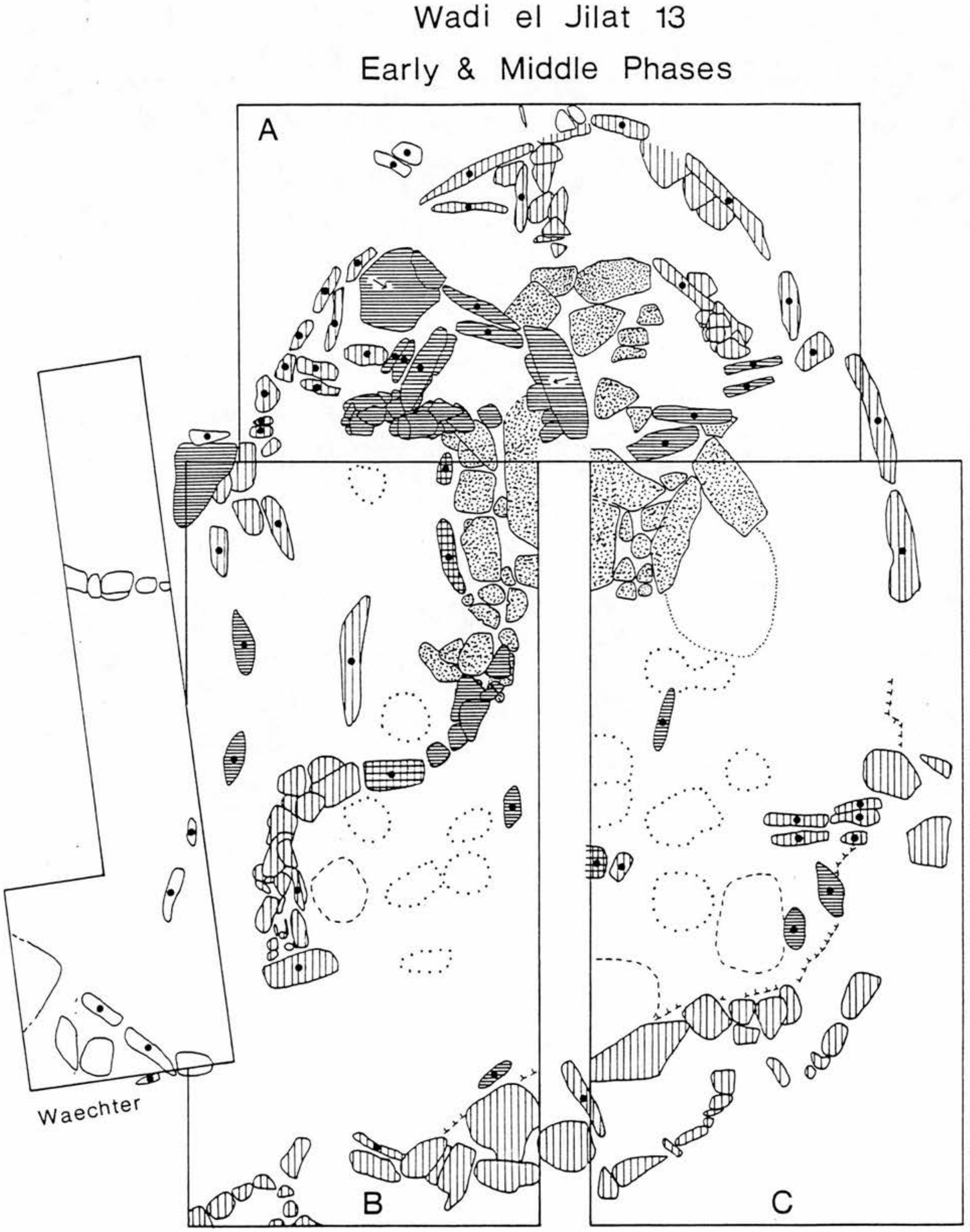


Fig.4.21

Wadi el Jilat 13

Late Phase

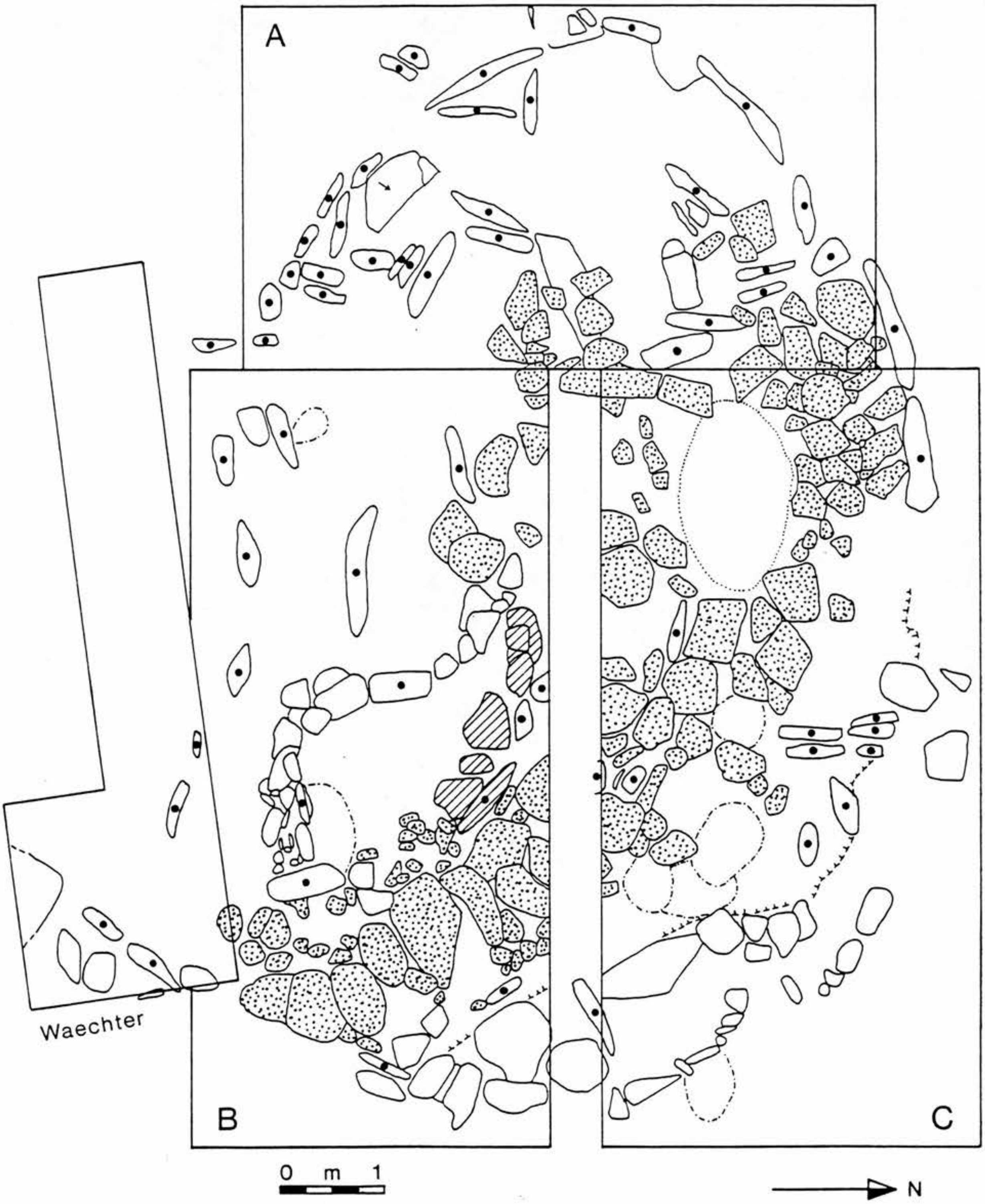


Fig. 4.22

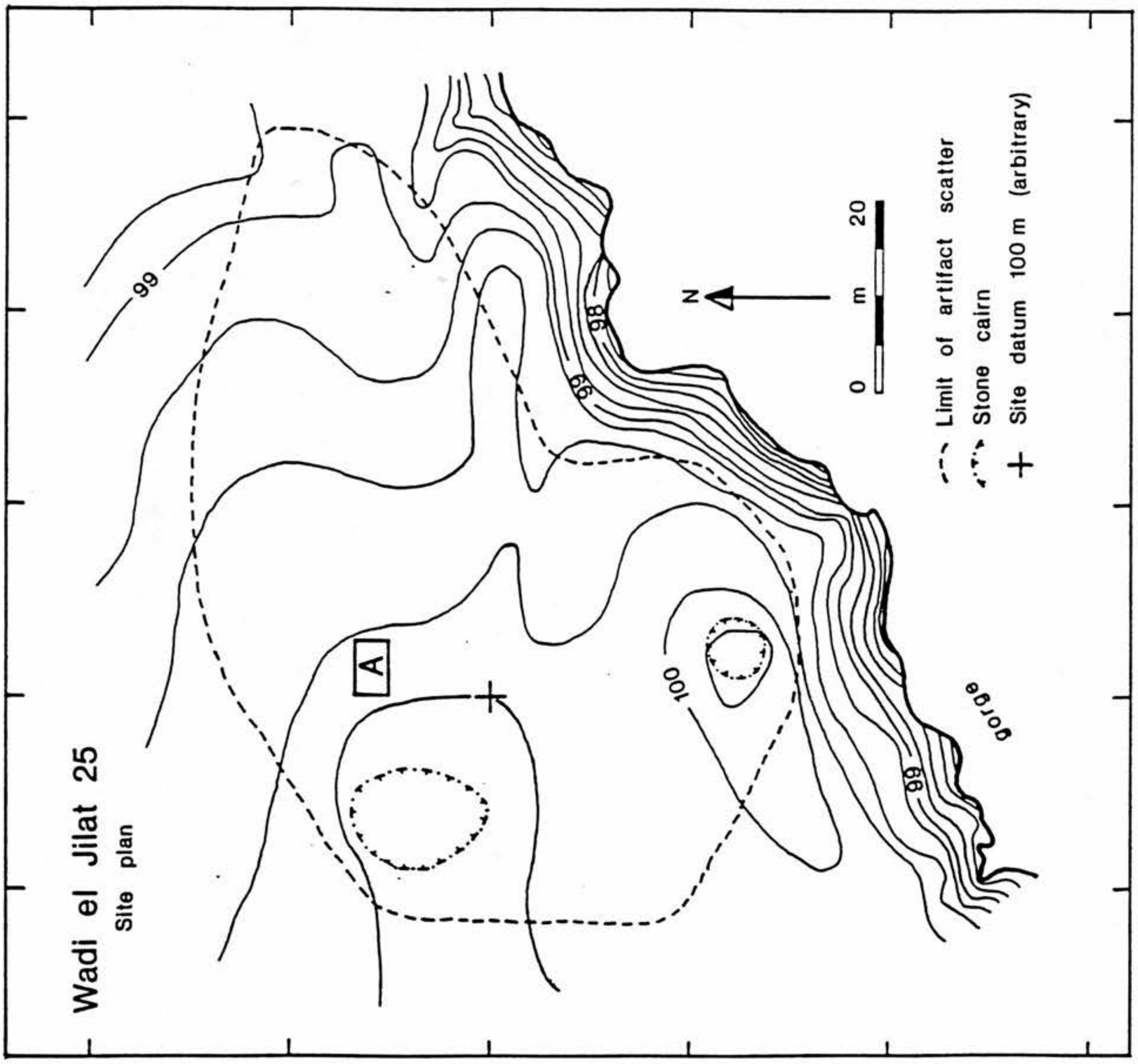

Wadi el Jilat 25
Site plan
99
99
98
99
100
A
gorge
N
0
m
20
Limit of artifact scatter
Stone cairn
Site datum 100 m (arbitrary)

Fig.4.23

Wadi el Jilat 25 Area A

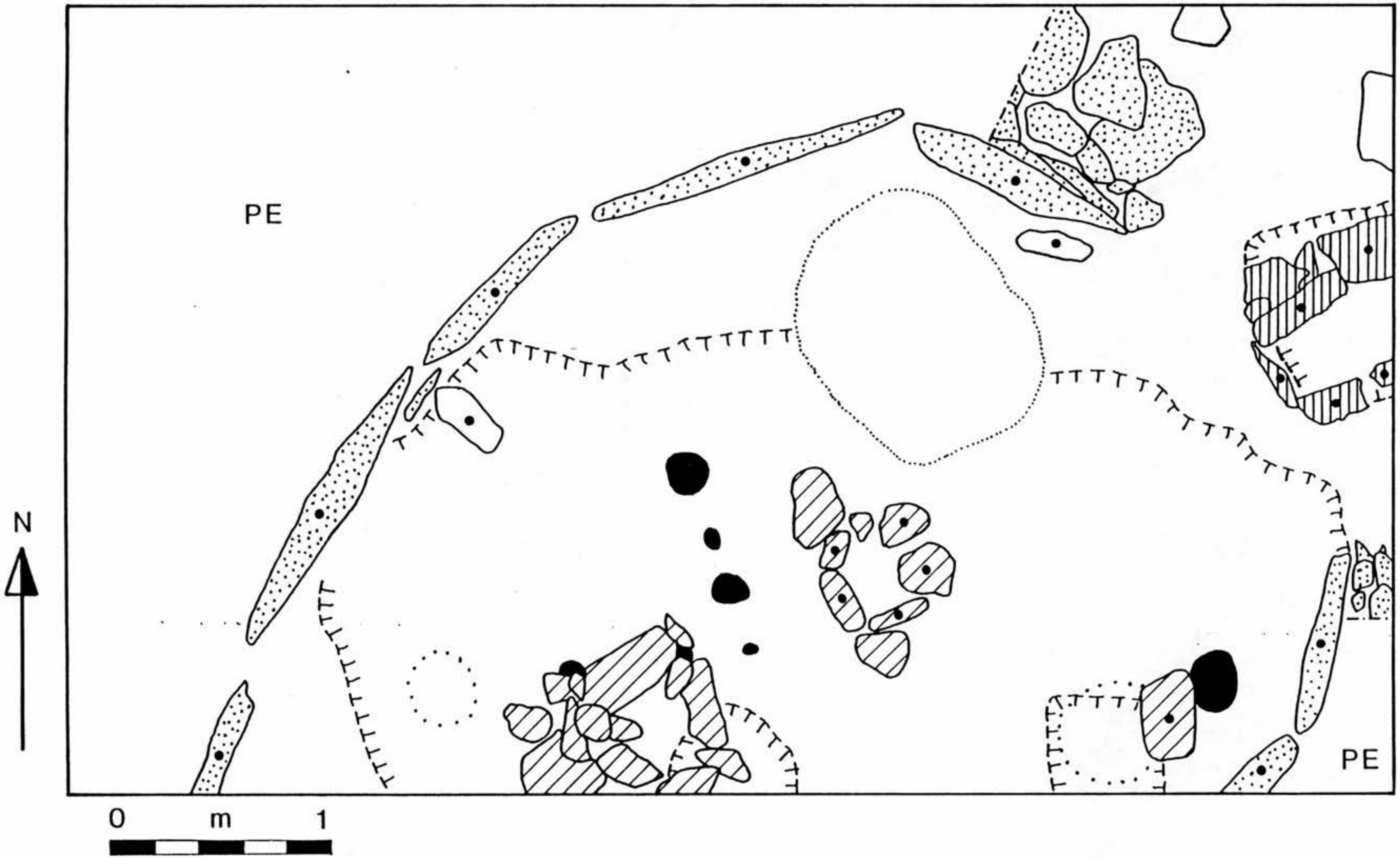


Fig.4.24

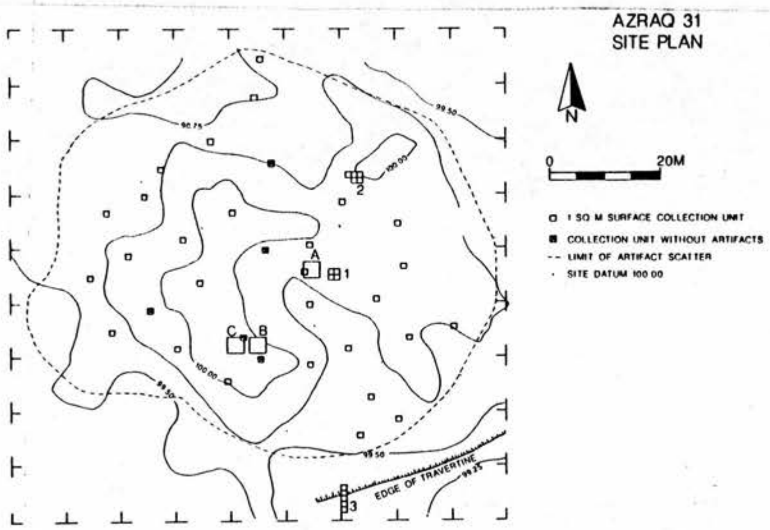


Fig. 4.25 Azraq 31 site plan.

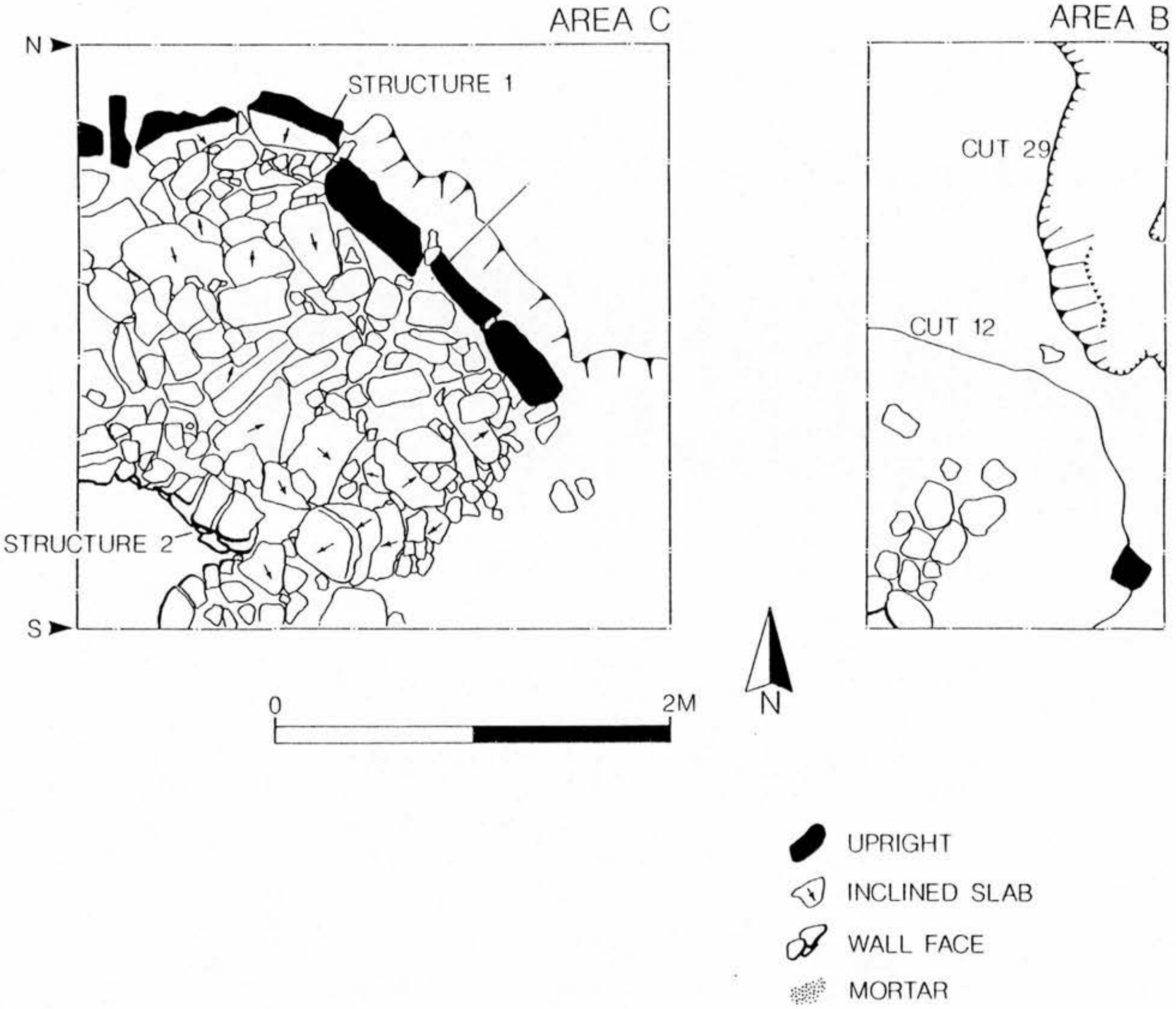


Fig. 4.26 Azraq 31 Areas B and C.

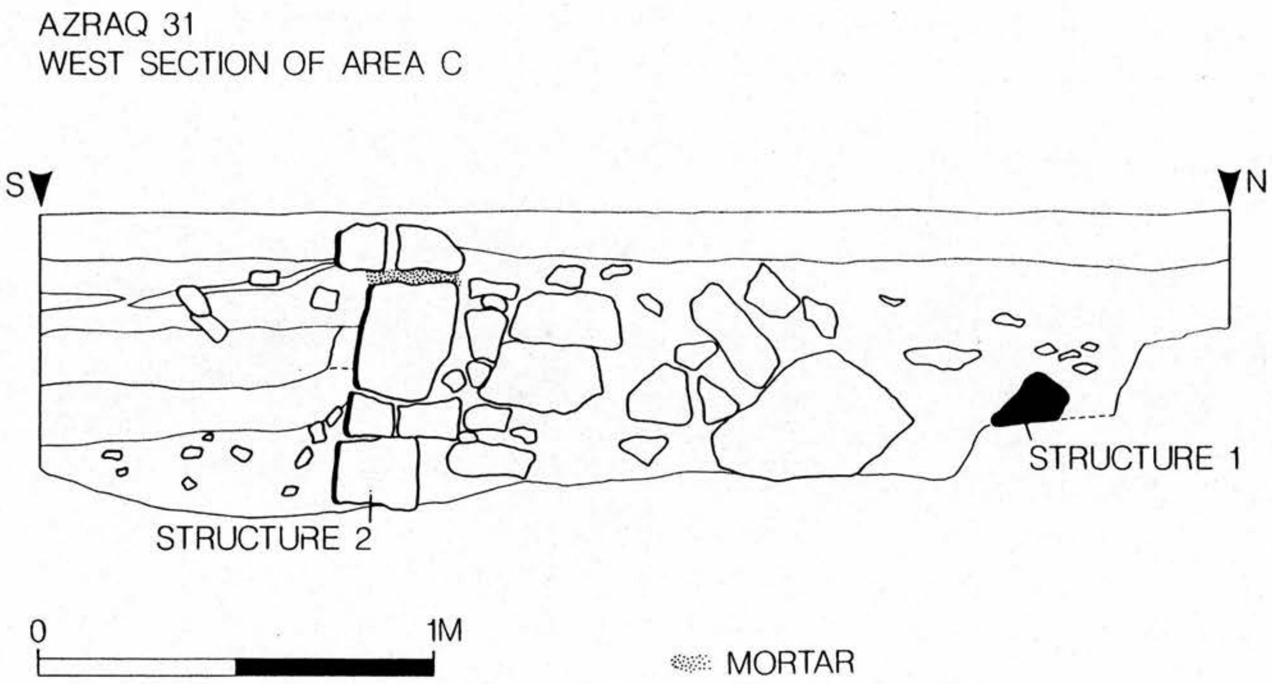


Fig. 4.26 Azraq 31 Areas C section.

SECTION 5

CLASSIFICATION AND ANALYSIS: THEORY, METHODOLOGY AND PRACTICE.

Section 5.1. The theory of classification.

The basic approach adopted in this analysis of the Azraq Project Neolithic chipped stone is that the existence of types is problematic (Binford 1972, 329-330). This is not to deny the occurrence of monothetic or polythetic clusters of attributes which distinguish one set of artifacts from another and which would therefore conform to notions of a type (Clarke 1978, 208-209, Klejn 1982, 59-62). The question is whether such empirical types (Klejn 1982, 81-83) can always be defined and whether they are a more appropriate vehicle for investigating past human behaviour than variation in attribute states themselves and therefore whether analysis should be aimed specifically at type formation.

Ideally an attribute would be the logical irreducible of Clarke (1978, 154-155), but as Clarke himself states "they are not quite such elementally pure units as one would like" (1978, 154). Clarke's concept that an attribute should reflect an action or micro-sequence of linked actions (Clarke 1978, 154) is important only if it is necessary that every attribute could be culturally meaningful; in practice it is doubtful whether it could be consistently guarantied. This is clear because Clarke's statement, that an attribute should be a fossil behavioural element, implies intentionality, conscious or unconscious, well or poorly executed. We cannot put such a restrictive definition on attributes. It is patently obvious that many multi-state attributes have the completely unintended character that they do because of a set of preconditions which may result from cross-cutting sets of micro-sequences of linked actions or the nature of the material being worked. Such preconditions may have been selected for or established with the purpose of controlling the production of the attributes in which we are interested or they may not. This very phenomenon is often in what we are interested. Clearly we do record attributes that are neither elemental nor the result of specific activity. For the purposes of this analysis an attribute is merely any aspect of an artifact that can exist in more than one state. Attributes are inevitably of varying levels of complexity and they carry no necessary intrinsic meaning, although such can clearly be deduced on occasion. Further, if an attribute is not a logical irreducible we cannot rely on it being a logically independent variable, a feature normally required of attributes selected for use in taxonomic systems (Clarke 1978, 156).

Clarke has provided a theoretical basis for the identification of types. Types exist in the form of sets of artifacts with discrete attribute clusters because of the nature of the designs in the minds of manufacturers. Whether effectively or ineffectively executed such percepta severely constrain variety in key attribute states (Clarke 1978, 153). However, is this necessarily a well founded model of purpose and execution on the part of manufacturers/creators of artifacts? On some occasions it is logical to assume that this is so - but on all occasions? Is it not admissible to envisage that intentions/requirements were so non-specific that much variability in attribute states would be unconstrained? Also might it not be that no more than one attribute or, even more problematic given our inability to deal with attributes as elementals, one component of an attribute might be a key attribute? In this lies the danger in searching for significant variability at the type level. What is important then is classification, not as the formation of types, but as the documentation of variability and the observation of differences.

There are practical as well as theoretical advantages to such an approach and I will argue it is particularly well suited to the study of chipped stone. What are the practical advantages? If types do exist, and that seems quite likely, we can better understand their nature and relationship to other areas of variability. Future identification of significant variation is more likely to be achieved using assemblages described in attribute terms. The object of any preliminary classification of chipped stone assemblages (and this study is no exception) is to provide a systematic, clear and coherent description of the assemblages. I argue then that it is more effective to do this at an attribute rather than a type level.

Any classification is clearly selective and it would be impossible systematically and coherently to describe every axis of variation in every object of every assemblage of every artifact type that occurs with frequency on sites (Sackett 1973, 318) and it would probably be meaningless (Adams 1985, 49). Classification inevitably involves value judgements (Adams 1985, 51). To be effectively descriptive we must go beyond predetermined categories whatever their proven 'value'in the past or we are in danger of relegating the observation of significant new variation to occasional chance observation. It is still usually necessary to utilise such categories or descriptive systems that can generate equivalent categories or we lose the possibility of comparison with previous work. This is the dilemma.

Section 5.2. Classification issues in chipped stone analysis.

I have argued above that the problematic nature of types is well exemplified by the case of chipped stone assemblages. Even when a design concept is in action, the non-plastic nature of the material inevitably limits the ability of even the most skilful to produce a set of products that standardly replicate design concepts. Variability is inherent in the product. Such variability can relate to randomising factors of variable fracture properties, flaws in material, skill and strength of different manufacturers, variations in manufacturing implements and many other factors. Because of such basic variability it may be very inappropriate to think in terms of clear distinctions between by-products and preferred products. Such distinctions may have been introduced as *post-hoc* accommodations by producers whether of blanks (see below) or tools. Instances of such are clearly documented by White and Thomas (1972, 278).

Tools, in the typological sense of retouched pieces of chipped stone, have been a focus of classification because pieces receiving modification after initial production are perceived as more likely to reflect producer/user intentions. There is a set of problems with classifying tools ranging from the consistent separation of modification preceding use from that induced by use, to the distinguishing of accidental/post-depositional damage. Further, tools can see several stages of use resulting in the presence of multiple areas of modification relating to different and possibly unconnected intentions, potentially inseparable from those with multiple areas of modification relating to the same purpose/use (section 8.1).

Section 5.3. Methodology of attribute analysis.

Variability in attribute states has been analyzed here using very basic procedures. Samples were compared for descriptive purposes and wider significance was adduced, not on the basis of statistical significance, but on the basis of contextual significance (section 1). Context was provided in two ways:- 1) by the discrete stratigraphic contexts in which the artifacts were recovered, which corresponded to discrete behavioural episodes (which at the very least thus had contextual significance in chronological terms); 2) by the inferential context of the attribute in relation to other attributes.

Descriptive statistics of a very simple and robust nature were chosen for comparative purposes. Thus groups, sets and ranges of attribute states were compared as distributions on scattergrams, and frequency curves. Differences between groups were noted and degrees of difference were described relative to the distributions under observation. The meaning or significance of any such variation in distributions is adduced from the contextual factors outlined above. Means of distributions were avoided because of the tendency for extremes to influence this summary statistic (Shennan 1988, 44). However, in comparative studies of relationships between Azraq Project data and that from other sites the mean was used of necessity.

Whether the difference between two samples is significant is one of the issues at the heart of the question of statistical significance and might thus be considered relevant. One key part of this question is that of sample size. In this analysis the view was taken that small samples, that is fewer than 100 examples of any attribute, were likely to provide a dubious basis for inference, that large samples were self evident and that beyond that preferably comparisons should be between samples of similar sizes.

Another key part of such questions is whether samples might derive from the same population. Statistical tests usually assume that the samples are random samples of some population. Because the samples analyzed were selected by their archaeological context and represent the total population from that or those contexts they are not necessarily to be seen as samples of a population, but as a population representative of specific behaviour. In another sense they are part of wider populations, but the parameters of such populations will vary dependent upon the level of focus and thus our contextual samples are certainly not random samples of any particular population. The significance of similarities or differences between different populations must be based on inferential context. Another basic assumption of some tests, that distributions should be assumed to be normal, does not necessarily fit all attributes.

For these reasons statistical significance and strength of relationship tests were avoided. Contexts provide the framework. Context samples being compared are in one sense already significantly different. The question in this setting becomes, are these meaningful differences reflected in a further clear and potentially meaningful manner. Significant differences in these terms and throughout the research are not statistically significant differences. If frequency distributions or dispersion diagrams of different sets of attributes are compared it is argued here 3 interpretive options are available. 1) Clear differences are observable because the distributions are dramatically different on a scale considered appropriate by the analyst and which cannot be ascertained to be appropriate by any statistical method. 2) Distributions are indistinguishable or virtually so at an appropriate scale. 3) It is unclear whether genuine differences exist. At this point it might indeed be appropriate to apply statistics to gauge the likelihood that samples are similar or different. I adopt a more cautious and sceptical view and advocate the suspension of judgement.

Section 5.4. Classificatory procedures for Azraq Project chipped stone.

The material was initially sorted into basic categories commonly used for other Near Eastern Neolithic chipped stone assemblages because 1) such categorisations provide a convenient way to handle large bodies of material such as the Azraq Project chipped stone assemblages, including the sampling of components of assemblages for more detailed attribute analysis. 2) Such categorisations employ certain attributes of proven value for understanding certain aspects of assemblages. 3) Assemblages thus categorized could be compared immediately, albeit in a manner of potentially limited significance, with other assemblages.

Most of these categories are conditional types with the dangers inherent in such types for masking potentially significant variability as outlined by Klejn (1982, 95 and 108-109).

Most basic breakdowns of chipped stone assemblages contain 2 groups of categories that are clearly not conditional. 1) Pieces that are removed from a parent body of material - as a group I shall term such removals - and 2) the parent body - cores.

Separated from both groups are tools, in the classificatory sense those removals or cores modified for some purpose or by some directed activity other than that directed to the production of removals. Henceforth when I refer to **tools** I will do so in the typological sense of individual retouched pieces of chipped stone unless I state that I am specifically referring to the possibility of tools in the sense of common day language, that is an **implement** quite possibly with several different components, including some of different materials. Tools can of course be modified removals or modified parent bodies = core tools. In the case of removals it is, in principle, relatively easy to distinguish tools - pieces modified after removal from a core. In practice it may be more difficult to distinguish modifications by intention or use from those occurring accidentally. Patterned scars on removal edges, or scars caused by the application of particular techniques (pressure flaking), are easily identified, but most retouch can only be distinguished by measures of relative regularity and extensiveness. Much depends upon the environment of deposition/exposure/redeposition of the material and its effects are best measured by the condition of the edges of the bulk of the material. Most relatively unpatinated non-surface material from Azraq Project sites had edges bearing almost no indication of damage or chipping. The exceptions were certain contexts on J26 and some of the material from Azraq 31. Even so a relatively rigourous line was taken in tool identification throughout the analysis. Any pieces with sporadic, irregularly disposed and variable scars, particularly those limited in depth from edge and in length as a group were not considered retouched and were placed in an edge damage category. The exception to this was Clactonian notches which were classified with tools with more elaborately retouched notches. The edge damage category undoubtedly includes some tools with irregular but deliberate retouch, some pieces that were damaged in use and undoubtedly many removals that are the product of accidental damage during manufacture, use and during or post-deposition. It has, sadly, been the experience of this analyst that at the irregular end of the 'retouch' spectrum there is no consistency between classifiers as to which pieces should be identified as retouched (partly because it requires the context of an examination of a considerable part of the assemblage). My hard line approach was intended so that almost all those pieces that I have assigned to a tool category would be so assigned by other classifiers. The size of this category is likely to vary from site to site dependent upon identification procedures and this must be borne in mind when making inter-site comparisons based on proportions of tools.

More intractable problems of classification exist in separating cores and tools. Thus some removals with extensive modification might be cores, in my terminology flake cores (as opposed to cores whose purpose seems to have been the production of flakes - in my terminology 'cores for flakes'). The classic type illustrating this problem is the *pièce esquillée* (White 1968). At least such are in a well defined and separable category however one wishes to infer their role. The most problematic pieces are those that do not fall into such well-defined categories. Some cores are clearly deliberately fashioned core tools, the most classic cases being axe/adze/chisels and the finely pressure flaked points and daggers found in many different industries. To distinguish flake cores and tools the most useful criteria were the nature and extent of the spalls removed from the removals, usually only clearly distinguished in negative on problematic pieces. If such spalls were never themselves retouched, or of a size feasible for use as tools, then clearly their parent bodies were unlikely to be merely cores for the production of such spalls. They would only be likely to be cores if such modification represented preparation. There is little evidence for the preparation of flake cores and the number of instances where any such hypothetical prepared flake cores went unreduced in the Azraq assemblages are likely to be very limited. Certain other pieces may have borne the scars of spalls that would have provided suitable tool blanks, but the scars were not in any number and these pieces were also classified as tools. Further, even if the spalls might have provided suitable blanks, if the pattern of removals related to those on other pieces which were clearly classifiable as tools, then the pieces in question were classified also as tools. Other pieces were placed in a problematic tool or core category or classified as cores, when removals were extensive enough. These latter were then analyzed with the non-flake cores to understand the nature of any relationships in reduction strategies. The exception to this rule was burins. Some of those encountered in the Azraq Project assemblages clearly represent cores for the production of burin spalls which were then retouched after removal as tools, mostly drill bits (sections 2.6.2 and 8.12.8), but, also rarely, as points on J25. Because such burins have been classified as tools in other assemblages in the past, it was felt necessary so to classify them here for comparative purposes. There are also more significant factors. It may be that such burins were also tools as well as cores and we have no way of determining the primacy of such roles. In addition and more importantly it is clear that all such burins were not necessarily cores (section 8.12.8) and we have no way of distinguishing which were cores from which were tools.

A more difficult area of categorisation in dealing with the Azraq Project assemblages, at least, was in distinguishing cores that were tools (i.e. pieces from which removals were made with the intention of using the final parent body) henceforth core tools from cores *sensu strictu*. In some cases core tools were easy to distinguish. They were those cases in which the actual form of the core was clearly a specific end in itself or those pieces whose morphology related them to recognizable tool classes. The latter are represented by rare axe/adze/chisels in the Azraq Project assemblages and the former by foliate or lanceolate bifaces and obviously related types the tile knives (figs. 8.3 and 8.4; section 8.12.3.2). The bifaces and tile knives are distinguished, in addition, because the negatives of removals relate to retouching rather than blank production. Such distinct retouch removals are usually a product of pressure flaking (fig. 8.3). The problem for categorisation is usually in distinguishing pieces whose morphology relates them to these tool types but whose irregularity brings into question their status as formal tool types. This was particularly the case with certain pieces that were similar to the bifaces and tile knives (fig. 6.4:3). This was so because it was clear that certain core preforms resembled these types (see below). Further, certain of these pieces, akin to tile knives, had bladelet removals, which on occasion, removed at least part of the bifacial edge (fig. 6.4:3; sections 6.2 and 6.5). Problematic pieces were assigned to the core tool indeterminate category and discrete groups, like the edge of bifacial tile knife related pieces, were grouped and subjected to attribute analysis with the cores.

In line with current usage it is considered appropriate to break down removals, other than tools, henceforth debitage following, for example, Nishiaki (1992, 77), into a number of categories. These are conditional types. It has been considered useful to distinguish pieces with cortex on two grounds. 1) Pieces with cortex must come from an exterior part of the raw material. At least some such debitage must be produced relatively early in the reduction process and a greater number of such pieces are more likely to be removed relatively early in the reduction process than later. Presence/absence and/or relative proportions of such debitage, in certain contexts or at sites as a whole, may inform on the locale of initial stages as opposed to later stages of production (Nishiaki 1992). Of course, in reality such an analysis can be conducted only in the light of inferences about the whole reduction strategy and some knowledge of the nature of the original raw material. It is quite conceivable that cortical pieces can be produced in considerable or greater numbers than non-cortical throughout a reduction sequence. Only pieces completely covered with cortex can be safely assumed to be initial products in the reduction sequence. For this reason it is worth distinguishing them. 2) The second reason for an interest in cortical pieces is a perception that such pieces with a blunt cortical edge might have made suitable tools, retouched or unretouched, hence the appellation naturally backed, *l'éclat à dos naturel* (Brézillon 1983, 96). It seems likely that this, if a factor at all, would vary from assemblage to assemblage, whilst admitting the possibility, it seems worthwhile to discriminate.

For these reasons the debitage assemblage was divided between completely cortical, partially cortical and non-cortical pieces. Pieces with cortex on their striking platform were classed with the non-cortical pieces. This was done because it seemed quite possible that cores might retain cortex on their striking platforms long after the rest of the core was decorticated. In the interests, therefore, of mapping the locale of different stages of production, the primary purpose of these particular conditional classes, it would be more useful to allow 'non-cortical' pieces to be so defined - they are pieces with non-cortical obverse surfaces.

The other classic conditional divisions of debitage relate to the size and morphology of removals. It was appreciated relatively early in the study of chipped stone that in certain industries elongated debitage (see below) was produced with considerable deliberation; for example, Brézillon (1983, 99) refers to the definition of blades by J. Garnier in 1862. This was because of the numbers in which they were produced compared to other industries and/or because they formed a high proportion of tool blanks. In due course core preparation techniques were identified that indicated that this was a deliberate strategy. Two approaches have been adopted to the categorisation of such debitage. The first, and probably more common one, has been to utilize the length:width ratio (along the axis of removal) of removals regardless of other features. By these definitions blades are twice as long as they are wide. Other definitions employ criteria of regularity (Nishiaki 1992, 79), for example, edges parallel/sub-parallel and parallel to the scar ridges on the obverse (Brézillon 1983, 99-100). This is partly to allow them to classify fragmented debitage. I have employed only the first criterion, 1) as this is the one most frequently encountered in Near Eastern Neolithic chipped stone studies thereby increasing comparability, 2) because it seems better to distinguish such arbitrary classes on limited and simple criteria and 3) because conditions of regularity are difficult to measure in a systematic manner. It is clear that a length:width ratio of at least 2:1 can be consistently applied by all analysts. Variations from assemblage to assemblage in raw material, reduction strategy and technique are likely to make more complicated arbitrary classifications difficult to employ, than classifications based on easily measured criteria and thus produce variations in the proportions of each category present which would be ascribable to the classifier. Measurements were made along the axis of removal/debitage, length was thus the maximum dimension of the piece along this axis and width the maximum dimension of the piece perpendicular to this axis (Tixier *et al* 1980, 39 fig. 2:1).

It has been realised for some time that small, elongated debitage was produced in significant proportions in some assemblages quite intentionally as blanks for relatively small tools - microliths. It has, therefore, seemed appropriate to distinguish bladelet from blade assemblages by distinguishing smaller from larger elongated forms. Usually this has been done on arbitrary criteria. Various thresholds of length and/or width have been employed, 50 mm. length, and/or 15 mm. width and/or 12 mm. width etc. (Brézillon 1983, 100). Before one has analysed an assemblage metrically such a distinction will inevitably be arbitrary and almost certainly cut across any significant distinctions that exist in the frequency of occurrence of different sized removal categories (section 6.7.2).

Given the necessarily arbitrary nature of the bladelet category, in a situation preceding detailed metric analysis, I decided to choose limits not completely incompatible with other studies but that would inform about the proportion of the smallest lamellar debitage in assemblages. I distinguished bladelets as 12 mm. or narrower and 40 mm. or shorter. A consequence of this distinction between blades and bladelets is that a certain group of material - broken pieces shorter than 40 mm. but 12 mm. or narrower - could have been blades or bladelets and therefore have been categorized separately in a general narrow blade/bladelet category.

Such distinctions based on the arbitrary selection of length:width ratios or specific metrical thresholds almost certainly will cut across significant variation within some assemblages or create divisions where none exist (section 6.7.2). On the other hand the significance of groups more precisely defined on the basis of their dimensions by exploratory analysis (frequency distribution and dispersion plots) can only be measured in terms of interpretations of reduction sequences, strategy and technique and some of the aims of knappers implied by tool types and their blanks. It is quite possible to envisage a situation where, although no discrete groups exist in metrical terms, and all pieces were produced as part of a continuous unvarying reduction strategy and technique, certain categories of product were required for certain purposes (sections 8.2-8.5).

It has been customary also to distinguish, again on an arbitrary basis, flakes below a certain size as chips (Nishiaki 1992, 82-83). This is partly on the basis that many such are produced as multiple, unintentional removals during knapping or retouching, during use, deposition and redeposition and that these smallest pieces were hardly ever required as tools, retouched or unretouched. It is difficult to separate consistently pieces of such size from pot lid fractures. Further analysis of features of such pieces (platform size and type etc.) might also be questionable. Of course, if this were intended as a meaningful distinction rather than an arbitrary one, it could be made only after attribute analysis of blank size of retouched tools. Size of such will depend on size of debitage available, at least partly raw material dependent. A meaningful class of this nature would vary from site to site (Nishiaki 1992, 83). Size definitions of between 10 and 20 mm. have often been used (Nishiaki 1992, 82-83). A preliminary inspection of tools suggested an arbitrary definition of 17 mm. would serve for initial categorisation of Azraq Project assemblages. All complete flakes below 17 mm. were placed in this category. Complete pieces, that might fall into other categories than flakes, although below 17 mm., would not be included e.g. bladelets shorter than 17 mm., tools, crested pieces (section 6.7.2).

Certain other categories represent empirical types whose significance has long been appreciated.

CRESTED BLADES. These are elongated debitage representing the removal from a core of a ridge created by a line of bifacial flake removals or flake removals, using as a platform a previous removal surface. Such removals will be mostly examples of preparation or re-preparation of cores; the crests thus created guiding subsequent removals thereby enhancing the creation of elongated removals. Therefore, pieces whose obverse ridges were modified after removal would be retouched not crested pieces. Of course, it is not always possible to distinguish this. It is possible only if cresting has cut away a removal edge (tool) or has been cut away by a removal edge (crested blade) or cresting cuts other retouch (tool). It is possible, therefore, that certain crested pieces are tools. In those examples that could be conclusively assessed core preparation/re-preparation dominated, hardly any clear crested tools existed. Many cores retain crests. Thus the vast bulk of this category will represent core preparation/re-preparation even if there are tools included. The crested blade category included some elongated pieces not quite twice as long as they were wide and fragments of pieces that probably had been twice as long as they were wide. In short the same strict criterion for inclusion in blade categories was not applied to crested blades on the basis that they were distinct because of their crests.

CORE REJUVENATION pieces were distinguished from other pieces because they represent the removal of significant parts of core platforms. This was most frequently deliberate refreshing of core removal surfaces (removal of hinge fractures = core edge pieces) and platforms (recreating or creation of suitable angles between core and removal surface = core tablets, core ends). Clearly the character of each rejuvenation piece will depend on core character, reduction strategy and the character of the rejuvenation process.

CRESTED ELEMENTS. The removal of the intersection of platform and removal surface could produce pieces difficult to distinguish from crested preparation pieces, particularly less regular, relatively short crested preparation/re-preparation removals. Pieces, that could not unequivocally be seen as crested blades or fragments or core rejuvenation pieces, were placed in a category of crested elements, which is, thus, likely to include preparation and rejuvenation elements.

EDGE OF CORE PLAQUETTE. One other category includes pieces that derive from both preparation and rejuvenation. These are a category recognised early in the Azraq Project study as a specific removal type. This debitage category represents the removal of the edge of a piece of tabular flint. As a result the right and left edges of the removal are represented by two cortical surfaces in parallel planes perpendicular to the central part of the obverse surface representing the edge of the core carrying cortex, a crest or the core removal surface (fig. 6.9). I have termed these the Edge of Core Plaquette or ECP for short. They clearly include pieces equivalent to crested blades, core edge pieces and core tablets. The bulk seem to be represented by the equivalent of core edge removals which, in this instance, can be envisaged playing the role of preparation or rejuvenation.

OVERSHOTS. A further technological category long recognised is the overshot - blade or flake. This represents the removal of a substantial part of the opposite end of a core as the distal end of a removal, frequently an opposite platform in opposed platform strategies. Usually it is considered to be a knapping accident, although there has been speculation that it might represent, at least on occasion, a deliberate rejuvenation attempt (Baird 1987, 467; Tixier *et al* 1980).

BURIN SPALLS. Other categories include various spalls. Burin spalls are usually clearly identifiable, although occasional pieces could be difficult to separate from bladelets. Where identification was problematic pieces would be included in the bladelet category. Such problematic cases only occurred when it was difficult to be certain that one of the obverse scars on the removal was in fact part of an inverse surface of a piece of the blank. Any spall clearly retouched after removal was classified with tools. Many spalls carried retouch that could well have related to the blank from which they were removed. A distinction was made on this basis then between spalls with retouch and those without retouch. Overshot burin spalls were distinguished on the basis of those spalls that had carried with them a substantial part of the opposite end of the blank.

Occasional products of retouching also could be identified. Such pieces included tranchet axe spalls, side blow blade flake type removals and spalls from the re-truncating of truncations or truncation burins.

CHUNKS. A category of chunks included any flint shatter products not evidencing clear conchoidal fractures, platforms etc.

INDETERMINATE CATEGORY. Any pieces that could not be assigned to the categories outlined above were placed into an indeterminate category. The bulk of this category consisted of blade-bladelet or flake fragments not well enough preserved to allow their assignment to blade-bladelet or flake categories. No attempt was made to separate lamellar fragments on the basis of regularity from the rest of the indeterminate debitage because it was felt no such distinctions could have been rigourously applied. It was clear that a distinct part of this material consisted of fragmented blade-bladelets whose proportions would have made them more prone to fragmentation than more robust flakes. It is also likely that blade fragmentation was a function of tool manufacture and use. The separation of chips and indeterminate debitage is not something always adhered to in Near Eastern Neolithic chipped stone analyses (Nishiaki 1992, 82-83) but seemed the most systematic approach in this context and one that would allow most flexibility with a number of assemblages categorized in slightly different ways.

The application of these criteria produces a number of categories into which Azraq Project chipped stone assemblages from certain selected contexts (section 1) were categorized. These counts are presented in appendix 1.

Primary/completely cortical flakes complete.
Primary/completely cortical flakes broken.
Secondary/partially cortical flakes complete.
Secondary/partially cortical flakes broken.
Non-cortical flakes complete.
Non-cortical flakes broken.
Primary/completely cortical blades complete.
Primary/completely cortical blades broken.

Crested blades complete.

Crested blades broken.

Crested blades in other categories.

Secondary/partially cortical blades complete.

Secondary/partially cortical blades broken.

Non-cortical blades complete.

Non-cortical blades broken.

Cortical bladelets complete.

Non-cortical bladelets complete.

Chips.

Chunks.

Overshot blades.

Overshot flakes or indeterminate pieces.

Overshots in other categories (tools, crested blades etc.)

Cortical blade or bladelets (broken pieces less than 40 mm. long and 12 mm. or less wide)

Non-cortical blade or bladelets (broken pieces less than 40 mm. long and 12 mm. or less wide).

Core rejuvenation pieces.

Cores.

Indeterminate debitage.

Tools

Burin spall without retouch.

Burin spall with retouch (not tools).

Overshot burin.

Crested elements.

Edge of core plaquettes.

Notch/retouch spall.

Tranchet spall.

Side blow blade flake (non-obsidian).

Edge damaged blades complete.

Edge damaged blades broken.

Edge damaged flakes.

Edge damaged indeterminate.

SECTION 6

THE TECHNOLOGY OF THE AZRAQ PROJECT NEOLITHIC ASSEMBLAGES

Section 6.1 Approaches to the analysis of technology.

The most liberating approach to the analysis of chipped stone assemblages in recent years has been that of attempting to reconstruct reduction sequences. This very approach has directed attention away from type-based study, with its concept of static and normative, monothetic entities, towards attempts to infer the dynamics of production. This is clearly a more realistic way to study human behaviour in relation to complicated and potentially idiosyncratically executed manufacturing processes.

Analytical approaches to reduction sequences have been offered by Bonnichsen (1977), Newcomer (1975), and Crabtree (1972) amongst others. They have broken manufacture down into separate analytical entities that can be approached through aspects of the material (Bonnichsen 1977). Newcomer (1975) distinguished method, mode and technique, Pellegrin (1981) method and technique, and Crabtree (1972) method, technique and manner. Method indicates the broad approach of knappers to the reduction of their material involving a series of steps during which characteristic removals are effected (Newcomer 1975, 97). It is thus manifest in sequences of particular removal types, number of platforms preferred, and relationships of platforms from which removals were made, etc.. I will refer to this as the reduction strategy as I believe this more appropriately sums up this aspect of reduction than the term method. Newcomer has made a further distinction between mode and technique. Mode for Newcomer represents the type of impactor, hard hammer, soft hammer, pressure (Newcomer 1975, 97-98). Technique for Newcomer involves all the other aspects of flaking, the way in which the core was held, angle of blow, direct or indirect percussion, point of impact on the platform, strength of blow, etc. It may be seen already that Newcomer's distinction is not a precise one. Pressure retouch is as much technique as mode - the way in which the force is applied is as important as the 'impactor' itself. Most analysts have not made a distinction similar to that between mode and technique. They prefer to treat this analytical aspect of reduction sequence studies as one (cf. Bonnichsen 1977 - input variables; Knutsson 1988, 18) and usually refer to it as technique, as I will. This is sensible, in that these aspects are not independent, pressure is the obvious example, but there are also dependent relationships between effective use of particular hammer types and angle and point of impact (Knutsson 1988, 38). Ohnuma and Bergman (1982, 163) point out that some of the characteristics that Bordes (1947) associated with hard and soft hammer removals, namely differently sized platforms, relate to effective use of the different hammer types. Bonnichsen (1977) suggested that the constant association of soft hammer flaking and lips on the edge of the platform adjacent to the bulb/inverse surface may relate to the preferred angle at which soft hammer percussion was undertaken. Further, since those attributes of removals and cores recorded to provide information on hammer mode and technique inevitably relate to both mode and technique as defined by Newcomer, it seemed inappropriate to make this distinction. It is clear that distinctions between strategy and technique are analytical. Neither are likely to be independent of one another (Knutsson 1988, 38). Treating them as analytically divisible entities may allow more significant inferences about variation in the behaviour involved.

It is clear that reconstruction of strategy can be effective only from observing the sequence of removals from a significant number of cores in a given assemblage. This would be done ideally by refitting. The circumstances which allow refitting are not that common, especially on settlements of the Neolithic period which often witnessed more intensive occupation than on at least some Palaeolithic sites and on which material is more likely to be transported from place of original deposition.

When refitting is not possible the pattern of scar removal can be reconstructed only by the negatives left on debitage and cores. Clearly cores provide the best source of information, in that the negatives of many removals are usually preserved and the pattern of their relationships can be observed along with platform number, characteristics and relationships. Specific preparation and rejuvenation removals, that is crested blades, core rejuvenation pieces, etc. as opposed to flakes and blades (that also might have been removed as part of preparation or rejuvenation processes) can illustrate, very effectively, certain stages of reduction. As cores represent the last stage of reduction (in their individual cases), a study of scar patterns on the debitage may be appropriate to understand early stages of reduction. Much depends on the character of the core assemblage itself. If cores were abandoned at several stages of reduction, if pressures of various kinds to 'exhaust' cores were not in operation and if core numbers of all appropriate raw material types are sufficiently present in assemblages, the consequent need to study debitage scar patterns is not as pressing as in assemblages with few, exhausted cores, perhaps only of certain sorts of raw material with potentially their own distinct strategies. Because initial study soon indicated that the former factors rather than the latter pertained in the Azraq Project Neolithic assemblages, only limited attention was afforded scar patterns on removals other than those specifically involved in preparation and rejuvenation.

Conversely, it seems more appropriate to study technique mainly in relation to removals. This is because these removals retain characteristics, particularly fracture characteristics and platform size, imparted by the nature of the impactor, point of impact, angle and strength of blow and therefore only sporadically present on cores. Specific aspects of platform preparation and angle of removals are, of course, evidenced on removals and cores alike. However, it is essential to study the removals in relation to these aspects because the preparation that preceded removal may not be preserved on the abandoned core and final flaking angles may be unrepresentative of the majority of flaking angles.

To summarise cores will inform more about strategy and removals about technique, although clearly attributes of both cores and removals will have some relevance to the study of either.

It has long been appreciated in the study of artifacts that constraints imposed by the nature of a raw material can have a considerable influence on the character of a finished product. Also that the final character of an artifact depends upon a certain interaction between the possibilities of a particular raw material and the design and execution of manufacturer and user (who even if different from the manufacturer may be involved in the modification of a product). Some aspects, at least, of variation in final products may well relate to differences in the initial raw material used. The obvious case in point, relating to the reduction of crypto-crystalline/micro-crystalline rocks (indeed any stone working), is that any modification is subtractive, that any product is smaller than the initial parent raw material and that variation in the size of parent bodies potentially could influence variation in size of final product and further discarded product. In the case of siliceous rocks like flint, chert etc., raw material morphology, grain character and presence and quantity of flaws and impurities, all, potentially, could have considerable impact. It is, therefore, also important to study relationships between variation in strategy and techniques and raw material type and wherever possible to document possible reasons for those relationships.

Since this is not a contextual study of production it is worthwhile prefacing the analysis with some indications of the nature of the setting of production. There is abundant evidence that a considerable bulk of the local raw material was reduced on site. Almost every context analyzed, from every site, contains abundant evidence of every stage of manufacture from primary flakes, crested pieces, many cortical flakes, flakes, blades, rejuvenation pieces and cores (appendix 1). Thousands of chips (section 5) relating to production are present (appendix 1). There is no evidence that most of this production debris is *in situ* although some may be. Only a few contexts contain evidence of specific production episodes, and these were not necessarily carried out *in situ* either. There is evidence of this in only one case. In context J13A21a it was possible to refit several flakes to a core. Some of these flakes had been retouched into tools. This indicates blank production and eventual abandonment or storage of the tools in one setting and probably tool manufacture in the same setting.

Section 6.2 Core classification.

Thus the classification of cores was undertaken with a view to maximising information relating to the documentation of variability in strategy (in particular) and technique. An initial classification was built up by recording variation in as many separate attributes as seemed appropriate to these aims. Traditional categories for cores were avoided at this initial stage in favour of this attribute analysis, although many attributes contained key components of traditional categories. Further, it should be noted, that the attribute states, apart from numerical ones, are not strictly exclusive. Some may be partly exclusive but many can be combined to give a more accurate description of that particular attribute or to indicate the degree of uncertainty allowed for in attribute state definitions.

Section 6.2.1 Attribute: Platform relationships.

The relationships of the platforms from which removals were made are clearly one indicator of strategy. This category, as with others (sections 6.2.4 and 6.2.6), required one major area of prejudgement in its exercise. That is in the distinguishing of preparation crests from platforms for main removal surfaces. Crests are formed using either previous flake scars which are part of the crest as a platform - primary, bifacial crests or the edge of previous unrelated removal surface(s) as a platform - secondary crests. In essence this question becomes, does a platform relate to a major removal surface as opposed to the creation of linear crests? In those assemblages where blade production was significant and blade cores common this did not prove a difficult judgement. In fact, it was only difficult where cores for flakes were involved. Some of these cases were judged clearly or probably preforms - those that had only crests in effect (fig. 6.6). Some discoidal cores are an example of the potential problem. Most are cores for flakes with platforms provided by previous flake removals. Removals created bifacial 'crests'. The concentric character of removals in relation to platforms was here considered the key. Clearly the pattern of variation within a particular assemblage played its role. Problematic pieces were assigned to categories on the basis of relationships with unequivocal pieces. The data relating to these attributes is presented in appendix 2.

<u>Attribute states:</u>

SINGLE: One platform from which main removal surface(s) emanated (figs. 6.1:2; 6.2:1; 6.3:2).

OPPOSED: Two platforms arranged opposite each other from which bidirectional removals were effected on the same plane or planes (figs. 6.1:4; 6.2:2; 6.4:1; 6.5; 6.7; 6.8).

ALTERNATE: Two platforms disposed opposite each other from which bidirectional removals were made on different planes.

TRANSVERSE: Two or more platforms from which removals were made, those from later platforms removing part of the earlier removal surface(s) (fig. 6.1:4).

CHANGE OF ORIENTATION: Two or more platforms from which removals were made on different planes, the later platforms being established on earlier (although not necessarily abandoned) removal surfaces (figs. 6.1:1; 6.3:1). A specific arrangement of platforms, covered by this definition, is defined and was placed in a separate category (see below - Acute reversed).

MULTIPLE: Two or more platforms from which removal surfaces emanated onto different planes. Platforms are not established on previous removal surfaces nor do removal surfaces cut previous removal surfaces.

PREFORM: The only removals relate to cresting (figs. 6.6; 6.7).

DISCOIDAL: Multiple platforms concentrically arranged.

90°: Two platforms disposed so that their respective removal surfaces form two planes that intersect at 90°.

ACUTE: Two platforms disposed so that their respective removal surfaces form two planes that intersect at an acute angle.

ACUTE REVERSED: Two platforms disposed so that their respective removal surfaces form two planes that intersect at an acute angle with the second platform located at the end of the first removal surface. A specific sort of change of orientation core.

Section 6.2.2 Attribute: Shape

<u>States:</u>

PYRAMIDAL: Removal planes converge on an apex. Three or four major planes, apart from that/those formed by striking platform(s), formed by removal surface(s) or cortical surfaces. Base of pyramid formed by major striking platform (figs. 6.1:2, 3, and 4; 6.2:2; 6.3:2).

PRISMATIC: Removal surfaces formed by several planes with parallel/sub-parallel edges and bases formed by striking platform(s) parallel to each other (if more than one) and perpendicular to axis of main removal surfaces.

IRREGULAR: Shape too irregular to fit into other categories. (Also includes pieces with only one or two removals - possibly test-flaked - and therefore of no specific shape which is characterised by original morphology of the raw material).

FLAKE: Core produced on a flake and shape of core dictated by original character of the removal.

FLAT: Flat in cross-section across main removal surfaces.

BIFACIAL: Any core evidencing relatively extensive bifacial flaking not associated with cresting.

EDGE OF BIFACIAL: Thin bifacially flaked core with some burin like removals using edge of biface as crest (fig. 6.4:3).

GLOBULAR: Multiple removal planes have created globular-shaped piece.

COBBLE: Wadi cobble modified on only one or two planes by removal surfaces, thereby largely retaining shape of original cobble (figs. 6.2:1; 6.3:1).

NAVIFORM: 'Boat-shaped' core, term first used by Jacques Cauvin (1968, 226-7). A crest to a greater or lesser extent opposite the main removal surface(s) of the core forms a keel for the 'hull' whose two ends are created by opposed platforms themselves created by removing part of the 'keel' crest or a previous 'keel' crest. At least one of the main bidirectional removal planes forms the 'deck', others or the original surfaces of the raw material form the sides of the 'boat'. The main bidirectional removal surface(s) form a flat or obtusely angled surface ('deck'). The key components of this definition are the two platforms angled toward each other, thereby forming a relatively acute angle with the main removal surface. The actual crest edge may have been removed, but if scars indicate the initial existence of such a crest a core will be classified as naviform. The crest does not have to be disposed directly opposite the main removal surface or along a central axis defined by such to fall into this definition of naviform (see below for descriptions of crest location) (figs. 6.5: 1, 3 and 4).

SUB-NAVIFORM. Certain pieces attained a morphology similar to that of naviform cores without some of the key components of the type which clearly relate to differences in reduction strategy. These are pieces without a crest or any indications of the initial existence of a crest. Thus the main bidirectional removal surfaces are relatively flat or obtusely angled, the two opposed platforms are relatively acutely angled in relation to those main removal surfaces, but the reverse of the core - between the two platforms bears no indication of a crest and is often represented by a cortical surface.

TABULAR EDGE: The overall shape of the core is dictated by the character of the original tabular material (see below). The narrow edges (perpendicular to the parallel planes formed by the extensive white cortical surfaces of the tablets) of the plaquettes provided the axis along which removals were made.

NAVIFORM-TABULAR: Naviform cores with characteristics of tabular edge pieces (figs. 6.5:2; 6.7; 6.8).

SUB-NAVIFORM-TABULAR: Sub-naviform cores with characteristics of tabular edge pieces.

Because of the definition of various related naviform core types i.e. naviform, naviform-tabular, sub-naviform and sub-naviform-tabular, I will refer to naviform cores *sensu lato* including all these types, and naviform cores *sensu stricto*, referring specifically to the naviform shape category in this analysis.

Section 6.2.3 Attribute: Main removal type

States: 1)FLAKE 2)BLADE 3)BLADELET

These states were judged by what appeared to be the main removal type on the main removal surface. Thus crests with, usually, their multiple flake removals were ignored even though on cores with crests flake scars might outnumber the negatives of blades or bladelets on main removal surfaces, the states were classified on the basis of removals from main removal surface. In addition the blade or bladelet removal presence often was judged on the basis of fragments of negatives of lamellar removals which did not have to accord to the definition of blade, bladelet removals. This was because many cores were abandoned with final removals of flakes with hinge fractures or crushed platforms which clearly had made the core difficult to work further and which affected significant parts of the main removal surfaces leaving only fragments of the main removal surfaces well preserved. In order to balance this subjective assessment a further more objective perspective was obtained by counting the negatives of flakes, blades and bladelets strictly defined in the same terms as the blanks.

Section 6.2.4 Attribute: Removal types

State: 1)NUMBER OF FLAKE REMOVALS, 2)NUMBER OF BLADE REMOVALS, 3)NUMBER OF BLADELET REMOVALS

Section 6.2.5 Attribute: Number of platforms.

Section 6.2.6 Attribute: Position of crest(in relation to main removal surface).

States: 1)OPPOSITE: crest is located directly opposite the main removal surface, on the same axis as the central axis of the main removal surface (figs. 6.5:4 and 5).

2)ASYMMETRICALLY OPPOSED: crest is located opposite the main removal surface(s) on an axis parallel to those removal surface(s) but not on the axis central to the main removal surface.

3)ADJACENT: crest is located immediately adjacent to (one of) the main removal surfaces on the same axis as those removal surfaces.

4)ON: remnants of a crest are located on the main removal surface.

5)RIGHT ANGLED: a type of asymmetrically opposed crest whereby the removals, of which the crest is composed, form a right angle (fig. 6.5:1 and 2).

6)TABULAR EDGE CREST: crest created by a series of flake removals across the narrow edge of a piece of tabular flint (figs. 6.6; 6.7; 6.8).

7)OFF-AXIS: axis of crest on a different angle to the axis of main removal surface.

8)TWO: two crests.

9)THREE: three crests.

10)PRIMARY: crest is a bifacially flaked example

11)SECONDARY: crest is created by flaking from a previous removal surface.

12)FULL: crest extends or probably extended originally almost full length or width of core.

13)LIMITED: crest only extends/extended limited portion of length or width of core.

Section 6.2.7 Attribute: Proportion of cortex. Measured as a percentage of the surface of the nodule in 5% increments.

Section 6.2.8 Attribute: Location of cortex (in relation to main removal surface(s)).

State:

1)OPPOSITE: cortex located opposite, directly or asymmetrically, main removal surface(s).

2)ADJACENT ONE SIDE: cortex located adjacent to one edge of the main removal surface(s) thereby excluding platform and end of core.

3)ADJACENT TWO SIDES: cortex located adjacent to both edges of the main removal surface(s) excluding platform and end of core (figs. 6.7; 6.8).

4)ON: cortex located on the main removal surface (fig. 6.4:2).

5)STRIKING PLATFORM: cortex located on the striking platform of the core (fig. 6.2:1).

6)END: cortex located at the end of the main removal surface(s) opposite striking platform(s).

Section 6.2.9 Attribute: Raw material types.

States: 1)TABULAR, 2)WADI, 3)NODULAR, 4)EXOTIC RED, 5)EXOTIC TRANSLUCENT, 6)WHITE, 7)OBSIDIAN.

1. Unmodified tabular flint/chert. This material is very distinctive. The material that was used on the prehistoric sites consisted of plaquettes between 10 and 100 mm. thick with distinctive, plane, upper and lower surfaces to the slabs, usually flat, occasionally uneven, covered with thick white or beige cortex (figs. 6.6-6.8). The thin edges of the slabs perpendicular to the extensive upper and lower surfaces, have become patinated, producing a distinct rough brown surface, by exposure of the edge of the eroding beds or the weathering of cracks in the beds (induced by the extreme thermal variation encountered in the steppe/desert or by geological activity). Very occasional pieces of tabular flint have one or two edges and surfaces of curving, nodular character (and still distinct because of the nature of their cortex), but these are very rare, resulting from infrequent unconformities in the flint beds. In grain this material could be described as medium fine. On fracture it does not produce surfaces as smooth as good south English chalk flint, for example, but fractures more smoothly than coarse grained cherts. In addition flaws, macrofossils and unconformities within slabs are very rare. This material is found on all the Jilat Neolithic sites and also at Azraq. The Jilat and Azraq material is essentially similar except for a difference in colour. The material from the Jilat sites is all grey to grey-brown. Occasional pieces have thin purple veins running through them, 1 mm. or less in thickness and spaced several millimetres apart with a thicker purple band immediately below the cortex, no more than 3 or 4 mm. thick. Such material is present also at Azraq but in addition some tabular material is a light blue-grey colour and darker brown material also is present. Much of the light blue-grey colouration may relate to patination of the material in deposits affected by their proximity to saline mud-flat and

marsh environments. The surface of knapped Jilat tabular material patinates brown, the material exposed on deflated surfaces as part of the flint reg, thus acquiring a so called desert varnish, patinates to a very dark brown colour.

2. Wadi cobbles. Most wadi cobbles are rounded nodules with curving and uneven surfaces. The cortex consists of the altered, heavily patinated and battered main body of the material unlike the tabular flint. On Jilat sites some of the flint is the same grey to grey-brown colour as the tabular material but much is a light mauve to purple grey. In addition, some wadi material is transported and thus modified tabular flint. Material thus captured in wadi systems soon loses its characteristic tabular flint surface qualities. Transport, even a few metres from the tabular bed outcrops, results in the removal of the classic dense white cortex leaving very battered although still plane surfaces. The edges of the slabs become rounded and lose their distinctive rough brown patina. Surfaces can take on a light blue patina. The overall slab characteristics allow this material to be identified as originating from the tabular beds. Fracture characteristics for all wadi material are the same as the tabular material, although wadi cobbles have somewhat more frequent flaws.

At Azraq the wadi cobbles seem to have many of the same characteristics except that the fracture qualities of the raw material are more varied and wadi rolled tabular material is absent. More coarse grained chert like material is present amongst the wadi cobbles utilised, with more flaws and rough fracture surfaces. However, in colour the main body of the material is usually grey and the light mauve to purple colours found in the Jilat wadi cobbles are absent.

3. Nodular material. Rounded nodules with smooth curving surfaces which display none of the battering or unconformities of the wadi material. This material has very dark grey

surfaces. It has a smooth fracture like both tabular and wadi material and the main body of the nodules is dark grey in colour.

Exotic materials. Whilst it pre-empts the discussion below (sections 6.6.2. and 6.6.3) on the precise localization of the sources of these different material types it is pertinent to isolate at this stage certain materials as being uncommon amidst the general range of material encountered on Jilat and Azraq sites. These materials were not encountered in raw form in a survey of the Wadi Jilat.

4. Exotic red = lustrous yellow, orange, dark purple, pink and red brown materials, wadi and tabular. The colouration and lustre of this material strongly distinguishes it from any of the other materials so far mentioned. There is one exception to this statement; lustrous dark purple material looks similar to the thin band of material occasionally encountered immediately below the cortex of unmodified tabular flint, but the latter is so thin that they are easily distinguished. The bulk of this material falls into a specific range in the Munsell colour system. The majority of pieces were 10R 3/3-4/8 variously described as dusky red, weak red, pale red; a smaller group was in the 5YR 5/3-6/6 range, that is light reddish brown to reddish brown to yellowish red and reddish yellow. One smaller component was 2.5YR 4/4 reddish brown-red. This material occurs in both wadi and tabular form, judging from those cases where cortex is present and it is unclear whether there is any specific association between particular colour groups and wadi or tabular types. The cortex on the tabular material is distinctive from that found on the more common tabular material on Jilat sites; it is smoother, thinner and light pink in colour. Some of the cobble material has light or white cortex. All this material is characterized by very smooth fractures. This material only occurs on J7. The occurrence of the reddish component to the colouration of this material might be suggestive of colour changes attendant on the oxidization of iron in flint/chert induced by heat

treatment (Domanski and Webb 1992). The obvious question is whether this might be heat treated Jilat material or not. The discussion of this issue is reserved until the evidence for sources of material is presented.

5. Exotic translucent yellow material. Partially translucent light yellow to yellow white material, tabular and wadi cobble. The partially translucent character of this material along with its yellow to yellow white colour distinguishes it clearly from all other materials in Jilat or Azraq. It has a relatively smooth fracture. Only one case of cobble flint was identified in this material (a core from J26), all others were from tabular slabs. This tabular material has a very distinct grainy yellow cortex. This material is only found only on J13 and J26.

6. Matt chalky white material. An homogeneous material without colour variation. No cortex survives on items recovered from sites to show the surface contours or other characteristics of this material. Only found on Azraq sites.

7. Obsidian. Obsidian occurs as very small numbers of pieces only on J7, J13 and Late Neolithic in Azraq 31. Its occurrence is so infrequent that quantification is meaningless. No cortical pieces or cores are present and most items are blade-bladelets (figs. 4.5:1-8).

Section 6.2.10 Attribute: Platform angles.

Angles between striking platform and removal surface, *angle de chasse* in the terminology of the French (Tixier *et al* 1980, 41 fig. 4). Angle recorded for up to three removals, for up to two of the platforms.

Section 6.2.11 Attribute: Core length,

measured along the axis of debitage of the main removal surface(s). If multiple removal surfaces on different axes maximum dimension of piece taken to be length.

Section 6.2.12 Attribute: Core width,

measured perpendicular to core length transverse to axis of removal of main removal surface(s).

Section 6.2.13 Attribute: Core thickness,

measured perpendicular to the plane on which length and thickness located.

Section 6.2.14 Attribute: Number of hinge fractures on piece.

Section 6.2.15 Attribute: Platform preparation.

States (appendix 2; section 6.5.4; table 6.9).

1)PLAIN: platform created by only one removal or remnants of one removal facet (figs. 6.2:2; 6.3:2; 6.4:2).

2)DIHEDRAL: platform created by two removals or remnants of two removal facets.

3)CORTICAL: cortex present on the platform (fig. 6.2:1).

4)PLATFORM EDGE DAMAGE: very small irregular scarring on the striking platform itself, immediately adjacent to removal surfaces, probably not deliberate.

5)LARGE FACETS: platform facetted by removal of more than two relatively large flakes from the edge of the main removal surface (fig. 6.4:1). Also referred to as coarse facetting (section 6.5.4, table 6.9).

6)FINE FACETTING: platform facetted by removal of multiple relatively small flakes along edge of removal surfaces from removal surfaces.

7)PREVIOUS REMOVAL FACETS: platform 'facetted' by presence of previous removals (figs. 6.1:2 and 4; 6.3:1).

8)REMOVAL SURFACE FACETTING: preparation of the removal surface adjacent to the platform, effected by grinding or small systematic, regular removals. In order to distinguish specifically the latter type of preparation examples of removal surface preparation were differentiated rigourously from crushing and random small flake removals. This was effected on the basis of the regularity and fineness of the scars, on the alteration of the intersection of platform and removal surface to produce a relatively regular edge, or in cases where very deliberate spur removal (the spurs between deep negatives of bulbs) was indicated (figs. 6.4:2; 6.5:1, and 3; 6.6; 6.7; 6.8).

9)CRUSHING: platform edge crushed.

10)RING FRACTURES: presence of ring fractures on the platform. These are circular ring cracks, sometimes circling the mark of an impactor, the tip of a Hertzian cone crack (Knutsson 1988, 42).

Section 6.2.16 Attribute: 1)Broken or 2)complete.

Section 6.3 Attribute analysis of a core sample.

A preliminary, detailed analysis of 250 cores, based on the above list of attributes, was conducted (detailed data in appendix 2). These were chosen from the most secure contexts, providing a sample representing all the Azraq Project Neolithic sites/period except J25 and the later phases of J13. As a result of this all cores, identified by preliminary sorting of the representative and secure sample contexts (sections 1 and 4.4), were classified on a more limited range of attributes which had been selected as significant on the basis of the preliminary analysis.

The discussion refers initially to the more detailed preliminary attribute analysis.

Each of the attributes represents rather different sorts of phenomena. Potentially, for example, number and relationships of platforms on cores are a strong reflection of reduction strategy. Likewise the number and relationship of the planes, created by major removal surfaces and platforms - in relation to the original raw material shape, are what dictate the shape of the core and also likely to reflect reduction strategy. A comparison of the varying attribute states of these attributes, in relation to variation in the other attributes, is likely to reveal the extent to which the varying attribute states in the attributes under study represent significant entities. In the case of platform relationships and core shape this question is whether the varying attribute states reflect different reduction strategies or different aspects of reduction strategies. Initially variation between these classes was studied without reference to temporal variation to attempt to identify attribute states significant through time.

Section 6.3.1 Platform classes:

Section 6.3.1.1 Platform and shape classes (sections 6.2.1 and 6.2.2.).

In the analyses of variations between cores of different platform classes it must be appreciated that some of the variation detected may relate more strongly, for example to other attributes recorded in shape or raw material classes. Since variation in shape may relate closely to different reduction strategies also reflected in variation in platform numbers and disposition, it seems appropriate to look first at how the platform classes are distributed across shape classes (appendix 2). The bulk of opposed platform cores are in fact of naviform or naviform-related types (naviforms *sensu lato*), there are also a few examples of tabular and prismatic shape. The discrete and homogeneous nature of the opposed platform group, in terms of its size range, must be ascribed to largely the naviform class itself (see below) and differences in platform angles may be clearer also in relation to different shape classes. Further discussion of variation in these attributes is therefore deferred until the shape classes have been considered. That there are differences between alternate and opposed platform cores may be explained partly by the fact that a relatively low proportion of alternate cores are naviform types *sensu lato*, most are in prismatic or tabular shape classes. 90° cores are divided approximately equally between naviform (*sensu lato*) and non-naviform types. Single platform cores occur in three main shape classes, pyramidal, prismatic and tabular edge, but with some cobble cores. Multiple/change of orientation/transverse cores I have tended to treat together because they appear to represent related strategies and occur in a less coherent range of shape categories, including irregular, cobble, prismatic, tabular and some pyramidal.

Section 6.3.1.2 Platform classes and main removal types (sections 6.2.1, 6.2.3 and 6.2.4).

There are few distinctions between the different platform classes relating to predominant blank type produced (appendix 2). A large proportion of cores had many removal types represented and therefore could not be assigned conclusively to a predominant removal class. Cores with only flake removals occur in all platform classes and are noticeably common only in the preform and discoidal classes. Blade cores are much more frequent in opposed and alternate categories than in other classes; they are in fact infrequent in single and change of orientation categories. This same tendency is to be observed for blade/bladelet cores. Opposed platform types also dominate the bladelet cores. On the other hand single platform and change of orientation and related cores are represented by a significant proportion of bladelet cores.

Section 6.3.1.3 variation in the sizes of different platform classes (sections 6.2.1 and 6.2.11-.13).

Variation in the size of the different platform classes was informative. Clearly size of abandoned cores will reflect many factors relating to very specific production events likely to cross-cut reduction strategies. It could reflect also variation in size of raw material. It seemed possible that relatively discrete size ranges of the different platform classes might be indicative of consistent factors relating to differences in reduction strategy or aspects of reduction strategy. A dispersion diagram of length and thickness against width of the different raw material types suggests that no distinct differences could be observed between tabular and wadi raw material cores (figs. 6.10-6.15). Cores of exotic red raw material, however, are clearly small in comparison with the bulk of the definitely local raw materials (figs. 6.12 and 6.15). Clearly this factor must be considered in relation to variation in size of the different platform classes.

Preforms are distinguished clearly on length:width criteria. Most are larger than most other cores (figs. 6.6; 6.7; 6.8; 6.16). This would be expected if, as suspected, they represent only the initial preparation of the block of raw material before more specifically desired removals have been generated. In effect then they represent a specific aspect of one or more reduction strategies (see below).

There appear to be no dramatic distinctions on length:width or thickness:width criteria between single and opposed platform cores (figs. 6.17 and 6.18). However, of some interest is the more dispersed distribution of single platform core sizes compared to opposed platform cores. It is possible that the more limited size range of most opposed platform cores indicates that they reflect a more consistent reduction strategy or homogeneous set of strategies than those represented by the single platform cores. A considerable proportion of the opposed platform cores are between 60 and 80 mm. long and 20-50 mm. wide (fig 6.18) and 20-40 mm. thick; but a very low proportion of single platform cores fall in this size range suggesting some differences (fig. 6.17). There is also a very significant group of single platform cores less than 40 mm. long and 40 mm. wide (fig. 6.17). Inspection of this group indicates that more examples of these single platform cores are of exotic red raw material than most single platform cores, so this group is at least partly material dependent However, there may be chronological factors at play also as a substantial part of this group comes from Early PPNB contexts and there is some reason to suggest that a number of others may well represent residuals from the Early PPNB.

Change of orientation, multiple and transverse cores differ from opposed platform cores in a manner similar to that for single platform cores with more dispersed distributions (fig. 6.19). There are suggestions of differences between multiple, change of orientation and transverse platform core classes and single platform core classes. There are a significant group of single platform cores less than 20 mm. wide (fig. 6.17) and hardly any multiple, change of orientation or transverse platform cores of this type (fig. 6.19). There appears to be a slightly higher proportion of slightly smaller multiple, change of orientation or transverse platform cores than single platform cores. These factors are quite likely to reflect the different character of reduction from these cores. If elongated removals were desired (sections 6.7.1 and 6.7.2), these could be produced on single platform cores as the width of the core decreased, on pieces where the tendency was to produce removals at an angle to previous removal surfaces, elongated removals could no longer be produced once the core had been reduced to a certain volume.

Alternate (fig. 6.21) and 90° (fig. 6.20) opposed platform cores both reflect types of opposed platform strategies; it was interesting to observe the extent to which they differed from other opposed platform cores. Despite small sample size the attribute analysis suggested some differences. The bulk of 90° cores (fig. 6.20) are smaller than the majority of opposed platform cores (fig. 6.18). The essential difference between most of these cores and opposed platform cores is in the angle of the main removal surfaces. Thus with opposed platform cores bidirectional removals are generated from one plane of 180° or slightly less, the 90° cores have bidirectional removals on two planes more or less perpendicular to each other. The latter have platforms that are angled more closely together. The fact that many 90° cores are smaller may indicate the rejuvenation of opposed platform cores to a point where removal surfaces became relatively sharply angled and platforms were angled toward each other. It is possible then that the 90° cores represent the final stage of the exploitation of some opposed platform cores. Sample size of alternate cores was rather small to make effective judgements. However, there is an indication that alternate cores were relatively wide compared to opposed platform cores.

Section 6.3.1.4 Platform classes and platform angles (section 6.2.1 and 6.2.10).

Platform angles reflect both strategy and technique. Potentially significant distinctions in platform angles might be present between the different platform based classes of cores helping to inform on differences in strategy. The frequency distributions of platform angles (at 2° intervals) of the different platform classes were compared. There were no major differences between opposed and transverse/change of orientation cores (fig. 6.22). The bulk of platform angles were between 69° and 93°, the majority of those between 75°-85°. Discoidal (fig. 6.24) and preform (fig. 6.25) classes did seem distinct but unfortunately the samples were only of small size. However, significant proportions of platform angles on discoidal cores are below 67° and numbers of platform angles of preforms are above 89°. Both these platform classes produced flakes, but clearly each in a rather different manner. The low platform angles of the discoidal cores can well be appreciated when it is considered that they are frequently flat bifacial cores. The platform angles of the preforms are almost all from platforms of preparation crests. The only, possibly, significant distinctions are between alternate (fig. 6.26) and opposed platform cores compared with change of orientation/transverse and single platform cores (fig. 6.28) in that the first two types have more high platform angles between 89° and 95°. Differences in platform angles may be clearer also in relation to different shape classes. Further discussion of variation in these attributes is deferred therefore until the shape classes have been considered.

Section 6.1.3.5 Platform classes, cortex location and cortex frequency (sections 6.2.1, 6.2.7 and 6.2.8).

It is likely that variation in the proportion and disposition of cortex remaining on cores is indicative of variation in strategy and degree of exploitation of cores.

The frequency distribution of the percentage of cortex remaining on cores does suggest fairly significant differences between opposed platform, multiple/transverse/change of orientation and single platform cores. Thus there has been extensive decortication of most opposed platform cores (fig. 6.29). 38.57% of all opposed platform cores have no cortex or less than 5%. Fully 88.57% have less than 55% cortex (fig. 6.29). Single platform cores are dramatically different. Only 4.48% have no cortex or less than 5%. Only 53.73% have less than 55% cortex (fig. 6.30). Change of orientation and related classes have a more even distribution across the cortex % range than either of these other classes, but a significant proportion are decorticated extensively, 28.95% have no or less than 5% cortex.

Logically decortication can be related to, at least, two obvious factors in reduction strategies: degree of preparation and extent of reduction. There is every indication that opposed platform cores saw extensive preparation and intensive reduction. There is some reason to believe that the preform class specifically represents preforms for opposed platform cores (figs. 6.6-6.8). By looking at the proportions of cortex on preforms we should be able to gauge the degree of decortication involved in at least some stages of preparation. The bulk of preforms, 56.25%, have between 65 and 85% cortex (fig. 6.6). A significantly sized group (just over 31%) also have between 35 and 55% cortex. A small group of opposed platform cores have between 65-85% cortex (fig. 6.7 6.8; 6.29) these are likely to have been reduced only slightly if they represent pieces that saw preparation. Another group with between 35 and 55% cortex (fig. 6.29) are unlikely to have been reduced extensively beyond preforming if preformed, but clearly the bulk of opposed platform cores were preformed (as naviforms - see section 6.3.2.1) and were reduced extensively, with no or less than 5% cortex (fig. 6.29).

The relatively high proportion of single platform cores with more than 65% cortex probably indicates the limited nature of preparation on single platform cores (figs. 6.2:1 and 6.30). A peak in numbers of single platform cores with between 55 and 65% cortex may indicate the more limited nature of single platform reduction (fig. 6.2:1). The peak in numbers of single platform cores with between 10 and 25% cortex must represent intensively reduced single platform cores (fig. 6.30). Clearly the nature of single platform production resulted in the removal of less of the core surface than opposed or change of orientation related strategies.

The significant proportion of multiple/change of orientation/transverse cores with no to 5% cortex (c.29%) indicates the way in which the shifting of the platform around the core resulted in significant decortication.

There is a strong tendency for higher proportions of opposed platform cores to occur in tabular raw material (section 6.3.1.7; figs. 6.4:1; 6.7; 6.8; table 6.1). In order to control whether this might be a factor in the differentiation of these platform classes in terms of surviving cortex proportions, the proportions of cortex on the different raw material categories were compared. Both wadi (fig. 6.31) and tabular (fig. 6.32) cores have significant numbers of pieces with more than 55% cortex preserved and relatively even distribution of pieces between 0 and 55% (although pieces with no cortex could not be identified to material type, unless exotic) suggesting that raw material type is not influencing directly the proportions of cortex preserved on cores. However, there are contrasts between the wadi and tabular materials suggesting certain factors at work (figs. 6.31 and 6.32). Least tabular material cores occur with between 50 and 65% cortex (fig. 6.32). This is exactly where the peak in numbers of wadi cores occurs (fig. 6.31). It is possible that this indicates a relationship between wadi raw material and single platform cores (section 6.3.1.7).

It is important to consider cortex disposition as well as proportionate occurrence. In this regard the contrast between opposed and single platform is clear. Opposed platform cores occur most frequently with cortex located adjacent to one edge of the main removal surface and fairly frequently with cortex on both edges of or opposite the main removal surface(s) (figs. 6.4:1; 6.7; 6.8). Cortex rarely occurs on striking platforms or main removal surface of opposed platform cores. Single platform cores most frequently have cortex adjacent to the main removal surface(s) on both edges or opposite (figs. 6.2:1 and 6.3:1). It occurs fairly frequently adjacent to one side of the main removal surface(s). But also on single platform cores, in direct contrast to opposed platform cores, cortex is located fairly frequently on the end (fig. 6.2:1), the striking platform (fig. 6.2:1), and on the main removal surface(s) (fig. 6.4:2) in that order of importance.

Change of orientation related types show a fairly equal distribution of cortex locations across the range and thus contrast with opposed platform types in particular, but also with single platform cores. This is clearly a function of the manner in which platforms migrate around the core in these types. 90° and discoidal core classes are of only small sample size and it is thus difficult to draw meaningful conclusions about the disposition of cortex on these types. The predominantly tabular raw material preforms (figs. 6.6-6.8) have cortex on striking platforms and opposite the platforms and significant proportions adjacent to the removal surfaces - in this cases the crests are formed by the removal of flakes across the thickness of the plaquette edge from one surface. The frequency of occurrence of cortex on adjacent edges of preforms indicates that only a limited number of edges were crested regularly on tabular preforms.

Cortex disposition gives some indication that there are significant differences in the reduction strategy represented by alternate compared to opposed platform cores. As with opposed platform cores cortex occurs most frequently opposite, and on one or two edges adjacent, to the main removal surface(s). On the other hand in contrast to opposed platform cores there is no particularly frequent occurrence of examples with cortex on only one edge, as opposed to two edges, adjacent to the main removal surface(s) and it occurs with relatively greater frequency on the main removal surface(s), end and striking platform(s) than is the case with opposed platform cores.

Section 6.3.1.6. Platform classes and crests (sections 6.5.1 and 6.2.6).

Some of these differences, in particular between opposed platform and other core classes, in proportion and disposition of cortex clearly relate to the degree of preparation of the naviform dominated opposed platform classes. This can be gauged further by the occurrence of preparation crests on cores. As might be expected, since most are naviform cores opposed platform cores are encountered frequently with crests (fig. 6.5). By definition most of these are located between the two opposed platforms (being the crests left after creation/rejuvenation of the platforms) opposite or in some way juxtaposed to the main removal surface(s). There are, however, a few examples retaining crests on the main removal surface. Further discussion of crest location on opposed platform cores is deferred to the more appropriate point of discussion of crest location on naviform cores (*sensu lato*). It is worth pointing out at this stage that the relative rarity of crests on the main removal surface of the opposed platform cores is a good indication of the degree to which these core types have been reduced beyond preparation/re-preparation stage, also indicated by the very low proportions of cortex preserved on opposed platform cores (see above).

Whilst single platform cores with crests are less common than is the case with opposed platform cores, the surviving number with crests (25 out of 69) is enough to suggest that initial preparation by cresting also must have been fairly common in this reduction strategy(ies). That such cresting was intended principally to guide the formation of the main removal surface is indicated by the number of examples with crests preserved still on the main removal surface (7 out of 25 examples). Crests occur in a variety of other locations on single platform cores indicating the variety of preparation/re-preparation strategies employed. Crests are less common still on multiple/transverse/change of orientation cores. This may indicate less of this sort of preparation, or more plausibly, the extent of exploitation of the surfaces of these cores with the shifting of their platforms. The location of crests adjacent to the main removal surface is among the most common position on this class of cores, not surprising given the shifting of main removal surface on these cores. Where tabular cores are involved the crests are frequently tabular edge types produced by the removal of CxF1 flakes (section 6.7.3, figs. 6.6-6.8), indicating that this type of preparation was not restricted to naviform or opposed platform cores. Multiple crests, with significant numbers on removal surfaces, were not uncommon indicating that platform shifts also were accompanied, at least sometimes, by the preparation of the new removal surface.

By definition all the preforms have crests and as might be expected, given that they are all tabular preforms, tabular edge crests predominate.

Section 6.3.1.7 Raw material use (sections 6.2.1 and 6.2.9).

Whilst table 6.1 (using all cores from all processed contexts, not just the preliminary sample of 250) indicates no exclusive or near exclusive relationships between raw material types and platform classes - broadly indicative of different reduction strategies we might now suggest - it does indicate some clear tendencies. Thus there are clear tendencies of a preference for tabular raw material for opposed platform strategies (fig.

6.4:1; 6.7; 6.8) and wadi nodules for single and change of orientation strategies (figs. 6.2:1 and 6.3). Given the possible influence of shape classes on these trends it seems more appropriate to defer detailed discussion until relationships between shape categories and raw material have been considered (section 6.3.2.8 and table 6.5). It can be stated that these tendencies probably result from the morphology of the raw material types. Thus tabular material might be more suited for opposed platform production in that the flat elongated planes characterising the bidirectional production of these opposed platform strategies already exist naturally on tabular material.

Table 6.1. Main platform classes, use of raw materials for total core sample, Jilat sites.

Core platform class	Raw material			
	Wadi	Tabular	Exotic red	Translucent
Opposed	74	164	9	2
Single	96	47	6	0
Change of orientation	91	34	9	3

Single platform production is characterised by removals around the circumference of one platform and the angular, multiple-plane character of the tabular material may have encouraged use of multiple platforms rather than extensive use of one single platform.

Given this evidence it might be possible to propose that the change of orientation/transverse/multiple platform classes sometimes actually represent the evolution of single platform cores.

Section 6.3.2. Shape classes (section 6.2.2).

Section 6.3.2.1 Naviform strategies.

As we have noted, the bulk of opposed platform types in the detailed attribute analysis are naviform types *sensu lato*. Much of the homogeneity of the opposed platform cores must be ascribed to the distinctiveness and homogeneity of the naviform class itself, especially in relation to the broader single platform and change of orientation related classes. Whilst detailed discussion of variation in the naviform strategy itself must await the discussion of the comparative status of the Azraq and Jilat Neolithic chipped stone technology, it seems appropriate to outline at this stage the most salient characteristics of the strategy and naviform cores themselves.

There have been several detailed discussions of the class, notably Suzuki and Akazawa (1971), Akazawa (1979), Crowfoot Payne (1983), Calley (1986b) and Nishiaki (1992). Whilst the distinctive final product of the naviform strategy had been recognized for some time before (Cauvin 1968, 226-7), it was not until the work of Suzuki and Akazawa (1971) on the factory sites in the Palmyra basin that the full nature of the reduction sequence was appreciated. A study of cores from several surface sites in the Palmyra basin (Suzuki and Akazawa 1971) amplified by work on locality 35 (Akazawa 1979), in particular, indicated clearly the nature of the reduction sequence with cores abandoned at several stages throughout it. The key component was the existence of a carefully designed bifacial core preform with asymmetric round or squarish transverse cross-section or occasionally triangular cross-section (Crowfoot Payne 1983, 667, Nishiaki 1992, 123). These preforms, oval, crescentic, D-shaped or semi-circular (Suzuki and Akazawa 1971, Nishiaki 1992, 122-3) thus provided crests for both preparation of the main removal surface and of the two opposed striking platforms. As both Calley and Nishiaki have pointed out, designed into the, thus aptly named, preform was the relative flatness of the bidirectional removal surface, the angle and extent of the striking platforms, in effect the naviform character of the final core by-product - hence the flattened D-shape, oval or crescentic character or segment of an orange shape (Crowfoot Payne 1983, 667) of the preforms. This is clear also from the naviform preforms excavated in Jilat, in particular the cache from J7A34 (figs. 6.6-6.8). Interestingly these naviform-tabular preforms further indicate the distinct nature of this strategy in that they lack the more fully bifacial character of naviform preforms *sensu stricto*.

Three or four crested blades would be produced after preforming was complete. The precise order of the removal of these blades seems to have varied (Suzuki and Akazawa 1971 and Crowfoot Payne 1983, 667), we know now even in the same production setting (Nishiaki 1992, 124). During blank production the core was switched round as alternating sets of removals were generated from each platform (sets of three or four removals at a time at Qdeir (Calley 1986b) and in Azraq and Jilat. This maintained a relatively flat bidirectional removal surface which sometimes shifted laterally around the edges of the platforms towards the reverse crest(s). Occasionally this could result in the removal of the reverse crest (Calley 1986b). Both Calley (1986b) and Nishiaki (1992) have suggested chrono-regional variability in the naviform method, specifically documented, by relative positions of removal surfaces and crests. This is discussed in more detail in the comparative study (see sections 6.5.6 and 7).

Section 6.3.2.2 Shapes classes and main removal types (sections 6.2.2, 6.2.3 and 6.2.4).

An assessment of most significant blank types, produced by particular core shape classes, was made (table 6.2) based on the counts of the particular removal types on cores (appendix 2). Both naviform and sub-naviform core classes have high proportions of pieces with blade or blade/bladelet removals and low numbers of pieces with specifically bladelet or flake removals (table 6.2).

The Tabular edge class has a high proportion of pieces with blade, blade/bladelet and a significant proportion with flake removals, but few with specifically bladelet removals (table 6.2).

Prismatic cores are to be contrasted. This class has pieces with specific preponderances of blade or flake removals and fewer examples with blade/bladelet or bladelet removals dominating (table 6.2).

In the pyramidal class blade and blade/bladelet cores are the most important but there are much more significant proportions bladelet and flake cores than in other classes (table 6.2).

Only the bifacial and cobble core classes have preponderances of flake cores which might suggest a genuine flake-blank production component of assemblages and even here it may relate only to the character and stage of the reduction strategies represented (table 6.2).

The analysis of the larger sample of all processed cores in terms of blank classes supports this picture.

Naviform cores classes *sensu lato* were consistent producers of blades and blade/bladelets. A few were bladelet cores.

Significant numbers of tabular, prismatic and pyramidal cores were blade and blade/bladelet producers. Pyramidal cores were the most significant producers of bladelets, however a small, but significant, number of tabular and prismatic cores were also clearly bladelet cores. On the other hand significant numbers of these core classes ended their lives producing flakes in contrast to the naviform class *sensu lato*.

Irregular cores, discoidal and to a slightly lesser extent flake cores were clearly producers of flakes rather than blade and or bladelets (table 6.2). The implication is that they were some of the few core classes in the reduction of which the desired product was flakes rather than elongated removals. This was probably the case with some cobble cores, but others were important clearly for blade/bladelet production and some of the cobble flake cores may well have been intended for blade/bladelet or elongated removals at some point during their lives.

Preforms and edge of tabular bifacials - which retain at least partially a preform character - are cores indicating flake production almost certainly as a function of their preparation.

Table 6.2. All cores, core shape classes: predominant blank type.

Core shape	Blade-bladelet	Bladelet	Flake	Mixed
Cobble	18	3	46	32
Discoidal	0	0	3	1
Edge of bifacial	3	3	6	4
Flake	4	0	7	5
Irregular	0	0	24	5
Naviform	67	7	2	6
Naviform-tabular	43	3	2	6
Preform	2	0	22	1
Prismatic	63	12	29	46
Pyramidal	28	8	13	21
Sub-naviform	23	1	1	2
Sub-naviform-tabular	17	0	1	4
Tabular edge	70	17	23	34

Section 6.3.2.3. Shape class core sizes (sections 6.2.2 and 6.2.11-.13).

In the case of the Jilat and Azraq core assemblage the size of naviform cores *sensu stricto* indicates a very discrete group of pieces relative to other core shape types, more homogeneous even than the group of opposed platform cores as a whole (fig. 6.33). They are relatively long and narrow compared to other core shapes. Interestingly the more specific naviform related shape sub-types show even more discrete characteristics, suggesting some validity to the distinctions. The majority of naviform-tabular and sub-naviform-tabular cores fall into a very specific length range compared to other naviform cores, that is 59-76 mm. (figs. 6.34 and 6.36). Their widths, however, vary across the full range of other naviforms. In these cases, of course, widths are influenced by the original thickness of the plaquette of tabular flint, which may explain the variability in this attribute state. It suggests also that a range of tabular raw material thickness was tolerated within certain limits. Naviform cores *sensu stricto* fall within the range 50-90 mm. in length and 20-45 mm. in width (fig. 6.33). Sub-naviform cores appear to be generally shorter than most naviform/naviform-tabular cores; most have lengths ranging from 42 to 62 mm. (fig. 6.35). Most naviform cores *sensu stricto* have a restricted width range (in comparison to naviform-tabular cores for example) of 27-37 mm. (fig. 6.33), presumably reflecting the optimum thickness of the original preform.

Pyramidal cores also form a relatively discrete group in terms of their size. Most pyramidal cores are smaller than most cores of most other shape groups (fig. 6.37). That these cores indeed do have distinctive shapes (presumably related to reduction strategy) is strongly indicated by the clear relationship between length and width of these cores.

Flake (fig. 6.38), irregular (fig. 6.39) and cobble (fig. 6.40) cores all have fairly dispersed distributions across the size range. These distributions can be contrasted with those of naviform *sensu lato*, prismatic (fig. 6.41) and tabular edge cores (fig. 6.42). These last three are relatively long compared to their width. In particular there is a comparatively large number of relatively long tabular edge cores. The width of these cores ranges from 14-40 mm., reflecting the thickness of the plaquettes used. The lengths of the prismatic cores fall over an extended range 20-100 mm., but they have also a relatively narrow range of widths, 20-50 mm. There may be some indication that there are three groups of tabular edge cores on size criteria.

Section 6.3.2.4. Shape classes and platform angles (sections 6.2.2 and 6.2.10).

Platform angles also show distinctions between the shape categories. Prismatic cores have angles that demonstrate a unimodal distribution curve with the bulk of angles occurring between 79° and 89° (fig. 6.44). Naviform cores *sensu stricto* show a multi-modal distribution of platform angles. They have significant numbers of relatively low platform angles, 73°-77° and of relatively high platform angles 89°-93°, as well as a significant-sized group of angles overlapping with those characteristic of the prismatic cores (fig. 6.45). The high platform angles probably relate to the frequency of platform preparation on naviform cores *sensu lato*. Whilst sub-naviform (fig. 6.46) and naviform-tabular types (fig. 6.47) do not have exactly the same distribution of platform angles as naviforms *sensu stricto*, they too show distinct multi-modality with significant proportions of particularly high and particularly low platform angles. Tabular edge cores (fig. 6.48), like the prismatic group (fig. 6.44), have an essentially unimodal distribution of platform angles but with a greater proportion of somewhat lower platform angles than prismatic cores. Pyramidal cores (figs. 6.1:2, 4; 6.2:2; 6.3:2), mostly single platform, derive their specific shape characteristics partly from the nature of the relationships between their platform and removal surfaces - therefore, as might be expected, they have a tight clustering of relatively low angles in the 75-81° range (fig. 6.49).

Section 6.3.2.5. Shape classes and the proportions and distribution of cortex on cores (sections 6.2.2 and 6.2.7-.8).

Naviform cores closely reflect the situation described for opposed platform cores in these matters (section 6.3.1.5). The bulk of naviform cores have no-10% cortex and none have more than 40% cortex (table 6.3). Interestingly significant proportions of sub-naviform cores occur with between 15 and 25% cortex suggesting that some, at least, are not merely naviform cores further reduced. It is suggested therefore that some represent a separate strategy which did not include the creation of multi-crested preforms.

Pyramidal cores are also distinct. Relatively significant proportions have no or low proportions of cortex on their surfaces (table 6.3). As mainly single platform cores this contrasts them with many others in this platform class (see section 6.3.1.5).

The most frequent occurrence of cobble cores is with c. 60% cortex (table 6.3). Mostly single platform cores they therefore fit a general pattern for single platform cores in contrast to the pyramidal types.

Prismatic cores occur in very significant numbers with more than 50% cortex, most frequently occurring around 60%. Pieces with c. 20-30% cortex are also relatively common.

Tabular cores have two modes of cortex frequency. The bulk of tabular cores have more than 50% cortex. Most frequently occurring are examples with c. 80% cortex. Only one example has less than 30% cortex and a significant group have 30-45% cortex (table 6.3).

Table 6.3 Percentage of cortex remaining on each shape class of core

Shape	Cortex %	Number
Pyramidal	0	4
Pyramidal	10	3
Pyramidal	15	4
Pyramidal	20	2
Pyramidal	25	1
Pyramidal	30	1
Pyramidal	35	1
Pyramidal	40	3
Pyramidal	45	1
Pyramidal	50	1
Pyramidal	55	1
Pyramidal	60	1
Prismatic	0	4
Prismatic	5	2
Prismatic	10	3
Prismatic	15	2
Prismatic	20	5
Prismatic	25	1
Prismatic	30	5
Prismatic	35	5
Prismatic	40	4
Prismatic	45	3
Prismatic	50	3
Prismatic	60	7
Prismatic	75	2
Prismatic	80	1
Prismatic	85	2
Prismatic	90	3
Cobble	25	1
Cobble	30	1
Cobble	40	1
Cobble	50	1
Cobble	60	4
Cobble	70	1
Irregular	0	2
Irregular	5	1
Irregular	15	2
Irregular	20	4
Irregular	40	2
Irregular	50	1
Irregular	80	1
Irregular	85	1
Irregular	90	1
Naviform	0	12
Naviform	1	2
Naviform	2	2
Naviform	3	3
Naviform	5	7
Naviform	10	3
Naviform	15	2
Naviform	20	3
Naviform	25	2
Naviform	30	2
Naviform	40	2
Sub-naviform	0	2
Sub-naviform	1	1
Sub-naviform	5	1
Sub-naviform	10	1
Sub-naviform	15	2
Sub-naviform	20	3
Sub-naviform	25	2
Sub-naviform	30	1
Sub-naviform	40	1
Tabular	5	1
Tabular	30	6
Tabular	35	2
Tabular	40	3
Tabular	45	2
Tabular	50	3
Tabular	55	1
Tabular	60	4
Tabular	65	2
Tabular	70	6
Tabular	75	4
Tabular	80	10
Tabular	85	3
Tabular	90	1
Tabular	95	2

This clearly reflects the manner of reduction of these pieces. The edges of the tablets are exploited continuously and removals are rarely noted from the extensive cortical surfaces of the tablet. Thus the cores will retain much cortex even after relatively intensive reduction.

The bulk of irregular cores have less than 40% cortex (table 6.3). Their irregularity results from the relatively intensive, but haphazard exploitation of the core surface.

The core shape classes show cortex location patterns that strongly relate their shapes to reduction strategies (appendix 2). Thus naviforms with their reverse crests and prepared platforms hardly ever have cortex on striking platforms/ends or opposite main removal surface(s). Given the nature of exploitation of the main removal surface it is not surprising that it is rare to find them with cortex on the main removal surface(s). The most interesting aspect of cortex disposition on naviforms is the rarity with which cortex occurs adjacent to both edges of the main removal surface, particularly when the raw material is mostly tabular (see section 6.3.2.8). This tends to suggest the asymmetric exploitation of the core either during preforming or during exploitation of the main removal surface. As we have seen (Calley 1986b, Nishiaki 1992) much has been made of the asymmetric exploitation of the sides of naviform cores in terms of chrono-regional developments; this issue will be documented further below, in relation to the Azraq Project Neolithic sequence (section 6.5.6).

Sub-naviform cores have similar patterns of cortex location but they have more cases with cortex opposite the main removal surface(s), a further indication that they are not the product of the reduction of the same sort of preform represented by the naviform cores.

The contrast of naviform types *sensu lato* with prismatic cores, some of which are also opposed platform, is clear on the basis of cortex location. Cortex occurs most commonly on these cores opposite the main removal surface. It is encountered, almost as frequently, adjacent to both sides of and/or on the main removal surface(s). It is encountered regularly on striking platforms and ends of cores.

By definition tabular edge cores have cortex adjacent to both sides of the main removal surface(s). In complete contrast to the naviform cores the next most frequent occurrences are striking platforms and ends of cores. Cortex occurs also with relative frequency on main removal surfaces and core ends. These occurrences of cortex, and the relatively high proportions of cortex on these cores, indicate the opportunistic nature of the reduction strategy of these cores, exploiting the natural angles of the tablets to maximise production of elongated removals with minimal preparation. This preparation did not include platforms and appears to have consisted in the creation of tabular edge crests by the removal of CxF1 flakes (section 6.7.3) as preparation, thus only of removal surfaces.

The sample of pyramidal cores is small and they have undergone considerable decortication. The most frequent location for cortex was on the striking platform.

Irregular cores, as their definitions might suggest, have a very heterogeneous character in terms of their cortex locations, but cortex is rare on two edges adjacent to the removal surface(s) or the removal surface(s) itself. This would be expected if the irregular cores represent the rather haphazard and opportunistic shifting of platforms over the core surface.

Section 6.3.2.6. Shape classes and their crests (section 6.2.2 and 6.6.6).

Crests are relatively rare on flake cores, cobble cores, pyramidal cores and irregular cores (appendix 2). This is not necessarily because these cores were not prepared by cresting, but, perhaps, because multiple crests were rare and thus residual crests are rare. However, it may also have been a less common practice in reduction strategies reflected by these types or crests may have been less extensive. The sample of preserved crests is too small to discuss significance of location, although they occur in various positions relative to the main removal surface(s) (appendix 2).

Tabular edge cores occur frequently with crests (appendix 2), mostly classic tabular edge crests created by the removal of diverging-edged flakes across the thickness of the edge of the plaquette material. These flakes, therefore, have cortical platforms and distal ends and only occasionally one cortical edge representing the corner of the plaquette (CxF1). Two crests are quite common as are crests on an edge adjacent to the main removal surface. These factors contrast these cores with naviforms even with naviform-tabular variants. As indicated above preparation and reduction were different for this core class even though it often consisted in bidirectional exploitation of the main removal surface. The opportunistic nature of the exploitation of the natural advantages of this core class is indicated with preparation of edges as removal surfaces but not platforms and the shifting of removal surfaces around the edges of the tablets not tied to prepared and specifically angled platforms created by preforming. The result was crests on, and on edges perpendicular to, the main removal surfaces.

Prismatic cores show an even greater contrast with naviform cores than tabular edge cores (appendix 2). Crests are not as frequent on prismatic cores as on tabular edge pieces. No crests occur opposite, most occur adjacent to and frequently on the main removal surface(s). Preparation was clearly significant and a certain amount of re-preparation may be indicated in the case of this class of cores with crests preserved both on and next to the main removal surfaces.

Section 6.3.2.7. Shape classes and platform preparation (sections 6.2.2 and 6.2.15).

Analysis of platform preparation was carried out on both the sample of cores recorded in more detailed and general fashion. Similar phenomena were noted (table 6.4).

As we would expect from the above analysis naviform cores *sensu stricto* have very few cortical platforms. A high proportion of naviform platforms are without preparation on the platform itself (table 6.4). However, compared to other core shape classes a relatively high proportion of naviform cores have both fine and larger scale facetting on the platform itself (table 6.4). In addition naviforms are distinguished by the relatively high proportion of preparation of the removal surface edge adjacent to the platform. There are also significant numbers with scars on platforms that probably relate to platform facetting or rejuvenation earlier in the use of the core. Naviform-tabular cores show closely related behaviour (in contrast to tabular edge cores- see below). The major area of contrast with naviforms *sensu stricto* is that the preparation of the removal surface adjacent to the platform is much more common than preparation of the platform itself. This is in contrast to naviforms *sensu stricto* and whilst fine and coarse facetting of platforms is more common than on non-naviform (*sensu lato*) classes it is significantly less common than on naviforms *sensu stricto* (table 6.4). Sub-naviform cores have a generally similar pattern of platform preparation but with slightly lower proportions of facetting in general and of fine platform facetting in particular (table 6.4). Sub-naviform-tabular cores are similar to sub-naviform cores except that, like their naviform-tabular counterparts, preparation of the main removal surface immediately adjacent to the platform is relatively more common than other forms of facetting (table 6.4). Fine facetting occurs on particularly low proportions of sub-naviform-tabular cores (table 6.4). The above suggests some relationship at least between naviform-tabular and their sub-naviform core counterparts.

Prismatic cores contrast with significant proportions of cortical platforms and significant, but not high, proportions of fine and larger platform facetting (table 6.4). Preparation of the platform edge of the removal surface occurs but is relatively uncommon.

Tabular cores also contrast with naviform cores *sensu lato*. High proportions have cortical platforms, slightly higher proportions than the prismatic cores. As with prismatic cores, but in contrast to naviforms *sensu lato*, fine facetting is more important than coarse, but in contrast to prismatic cores fine facetting is considerably more important than coarse and preparation of the platform edge adjacent to the removal surface is relatively significant (table 6.4).

Cobble, pyramidal and irregular cores are similar and contrast with the other core shape classes in that they have particularly low numbers of cores occurring with fine, coarse or removal surface platform preparation and the highest proportions of cores with cortical platforms (table 6.4). The first two of these classes are of course single platform strategies *par excellence*.

The edge of tabular bifacials have platform preparation that links them most with prismatic and tabular cores (table 6.4). There are relatively low numbers of cores with evidence of removal surface preparation, but significant numbers with fine and coarse platform preparation. Cortical platforms are significantly rare.

Table 6.4. Core shape classes: platform types.

Core shape	Removal surface	Fine	Coarse	Cortical	Plain	Total
Cobble	6	9	5	46	69	95
Discoidal	1	1	0	1	4	4
Edge of bifacial	1	3	3	2	9	16
Flake	2	2	2	3	17	21
Irregular	1	1	3	13	23	29
Naviform	29	26	30	4	77	82
Naviform-tabular	26	11	11	5	43	49
Preform	0	0	0	18	16	25
Prismatic	5	30	24	57	121	156
Pyramidal	4	2	5	34	48	70
Sub-naviform	10	5	6	3	24	27
Sub-naviform-tabular	6	1	5	2	19	22
Tabular edge	23	26	13	59	101	144

Core shape	Removal surface	Fine	Coarse	Cortical	Plain
	%	%	%	%	%
Cobble	6.31	9.47	5.26	48.42	72.63
Discoidal	25	25	0	25	100
Edge of bifacial	6.25	18.75	18.75	12.5	56.25
Flake	9.52	9.52	9.52	14.28	80.95
Irregular	3.44	3.44	10.34	44.82	79.31
Naviform	35.36	31.70	36.58	4.87	93.90
Naviform-tabular	53.06	22.44	22.44	10.20	87.75
Preform	0	0	0	72	64
Prismatic	9.61	19.23	15.38	36.53	77.56
Pyramidal	5.71	2.85	7.14	48.57	68.57
Sub-naviform	37.03	18.51	22.22	11.11	88.88
Sub-naviform-tabular	27.27	4.54	22.72	9.09	86.36
Tabular edge	15.97	18.05	9.02	40.97	70.13

Section 6.3.2.8. Raw material use for shape classes.

Table 6.5. Use of raw material in different shape classes, total core sample:

Core shape	Raw material			
	Wadi	Tabular	Exotic red	Translucent
Cobble	87	3	1	1
Discoidal	3	0	0	0
Edge of bifacial	0	12	0	0
Flake	9	8	0	0
Irregular	16	6	2	2
Naviform	14	36	1	2
Naviform-tabular	13	45	1	0
Preform	7	17	0	1
Prismatic	78	35	12	2
Pyramidal	48	3	9	0
Sub-naviform	9	12	1	0
Sub-naviform-tabular	0	21	1	0
Tabular	22	119	2	0

Some of the relationships between shape classes and raw material use appear to be exclusive or near exclusive, in others the tendencies displayed in the relationships appear stronger (table 6.5) than those between platform classes and raw material types (table 6.1).

Two of the strongest relationships are created by the definitions of the shape classes. These are, of course the cobble and tabular edge categories which respectively are completely dominated by wadi and tabular raw material (table 6.5). These classes suggested themselves, however, because of the differing exploitation of the different raw material which has partly been demonstrated by indications of different preparation and different distribution across the platform classes. The distinctiveness of these categories in themselves is a good indication that reduction strategy was raw material sensitive.

The other independent categories also suggest this. The small number of, but nevertheless distinct, edge of bifacial pieces were always on tabular plaquettes (fig. 6.4:3). Discoidal cores in contrast, although sample size is small, always seem to have been wadi cobbles. The pyramidal cores, which have appeared very distinct in the analysis of several attributes, are almost all wadi cores (fig. 6.3:2). Clearly, it would have been a very particular reduction strategy that would reduce the prismatic tabular body to the converging sided pyramidal core product. Most pyramidal cores are single platform (especially with significant numbers of cobble cores) which contributes to the tendency noted for single platform cores to utilise wadi material.

We might expect, from their prismatic morphology, that prismatic cores would be dominated by tabular blocks, but, in fact, wadi cores occur as significant proportions of this core shape class (table 6.5). This tends to indicate that raw material morphology did not completely dominate production.

The tendency noted, for opposed platform cores to have a higher than expected proportion created on tabular raw material (table 6.1), is actually a reflection of the even stronger relationships between naviform cores and tabular material. Even naviform cores *sensu stricto* have a distinct tendency to prefer tabular material and if naviform and naviform-tabular cores are considered together this is slightly stronger (table 6.5). Sub-naviform-tabular cores naturally demonstrate an exclusive relationship, but a further indication of the distinction between sub-naviform and naviform/naviform-tabular cores is indicated by much less clear relationships between this shape class and raw material types. The naviform-tabular cores on wadi raw material are almost all on wadi rolled tabular material and some of the naviform cores *sensu stricto* are on similar wadi material but not all. Clearly, it was quite possible to execute naviform strategies on wadi cobbles, but knappers preferred tabular material. As the significant number of naviform-tabular pieces indicate there was a tendency to exploit the edges of the tablets as relatively flat bidirectional removal surfaces. However, the significant number of non naviform-tabular cores of tabular raw material indicates that the attractions of this strategy was not the only reason for a preference for tabular material. It is likely that the morphology of the plaquettes made them particularly suitable for producing naviform preforms, whatever the precise nature of the preparation or reduction beyond this stage.

Irregular cores are dominated by wadi nodules (table 6.5). This is presumably a reflection of the fact that irregularly reduced tabular material will retain the original relatively regular character of its tabular parent body more often and thus be grouped as a prismatic core.

Section 6.4. Summary: reduction strategy and core type.

The attribute analysis of all cores regardless of their chronological context has suggested some validity to both platform classes and shape classes as indicators of different reduction strategies. Consistently the shape classes appeared to be more discrete entities than platform classes, with much of the distinctiveness of the opposed platform class deriving from the dominance of this category (particularly in the more detailed smaller sample attribute analysis) by naviform cores *sensu lato*. It appeared then that there was some long term significance, in terms of reduction strategies, to these classes. However, it was felt information relating to variation in strategy would be maximised if platform and shape classes were combined to analyse variation through time. It seemed inappropriate to assume that reduction strategies necessarily spanned lengthy time periods. A final analysis of reduction strategy must await a study of variation through time in production and attributes of these classes.

Section 6.5. Temporal variation.

Chronology was established on the basis of the stratigraphic sequences from the sites, projectile point type occurrences (relative chronological framework) and C14 dates (quasi-absolute chronological framework) (section 4.4).

Section 6.5.1. Core shape and platform classes.

Table 6.6. Numbers and percentages of each shape/platform class by occupation.

Table 6.6a

	J7I	J7II	J7B9	J7A14	J7III	J26	J32	A31I	J13I	J13II	J25	A31II
Cobble Opposed	1	0	0	0	0	0	0	0	0	4	0	0
Cobble Single	3	1	1	1	1	4	0	0	4	13	9	0
Cobble Change	4	0	0	1	1	2	0	0	4	18	21	0
Discoidal	1	0	0	0	0	1	0	1	0	3	0	0
Edge of bifacial	0	0	0	0	0	2	1	0	2	2	3	6
Flake	2	1	0	1	3	1	1	1	2	5	3	2
Irregular	6	0	0	2	3	4	0	0	2	3	7	0
Naviform	5	9	4	3	14	34	3	2	3	3	0	1
Naviform-tabular	4	2	1	0	4	33	1	0	2	2	0	1
Preform	5	1	0	3	3	12	0	0	4	6	5	0
Prismatic Opposed	11	2	0	0	4	6	0	0	0	13	1	1
Prismatic Single	16	2	1	3	5	4	2	0	2	3	2	1
Prismatic Change	8	6	0	0	5	6	0	0	1	11	11	0
Prismatic Alternate	1	1	0	0	7	3	0	0	1	8	4	4
Pyramidal Opposed	3	0	0	0	0	0	0	0	1	3	0	0
Pyramidal Single	5	0	1	2	2	2	1	0	0	12	11	0
Pyramidal Change	9	0	0	1	2	0	0	0	0	8	5	0
Sub-naviform	2	0	1	0	8	8	0	0	0	2	2	1
Sub-naviform-tabular	0	0	0	1	0	12	0	0	1	3	1	1
Tabular Opposed	2	0	2	0	1	9	0	2	2	12	7	1
Tabular Single	2	0	0	0	2	18	0	0	4	10	8	1
Tabular Change	3	0	0	0	2	9	0	1	0	8	3	0
Tabular Alternate	2	0	0	0	5	9	0	0	1	4	1	0
Total	95	25	11	18	72	179	9	7	36	156	104	20

Table 6.6b

	J7I	J7II	J7B9	J7A14	J7III	J26	J32	A31I	J13I	J13II	J25	A31II
	%	%	%	%	%	%	%	%	%	%	%	%
Cobble Opposed	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.56	0.00	0.00
Cobble Single	3.16	4.00	9.09	5.56	1.39	2.23	0.00	0.00	11.11	8.33	8.65	0.00
Cobble Change	4.21	0.00	0.00	5.56	1.39	1.12	0.00	0.00	11.11	11.54	20.19	0.00
Discoidal	1.05	0.00	0.00	0.00	0.00	0.56	0.00	14.29	0.00	1.92	0.00	0.00
Edge of bifacial	0.00	0.00	0.00	0.00	0.00	1.12	11.11	0.00	5.56	1.28	2.88	30.00
Flake	2.11	4.00	0.00	5.56	4.1	70.56	11.11	14.29	5.56	3.21	2.88	10.00
Irregular	6.32	0.00	0.00	11.11	4.17	2.23	0.00	0.00	5.56	1.92	6.73	0.00
Naviform	5.26	36.00	36.36	16.67	19.44	18.99	33.33	28.57	8.33	1.92	0.00	5.00
Naviform-tabular	4.21	8.00	9.09	0.00	5.56	18.44	11.11	0.00	5.56	1.28	0.00	5.00
Preform	5.26	4.00	0.00	16.67	4.17	6.70	0.00	0.00	11.11	3.85	4.81	0.00
Prismatic Opposed	11.58	8.00	0.00	0.00	5.56	3.35	0.00	0.00	0.00	8.33	0.96	5.00
Prismatic Single	16.84	8.00	9.09	16.67	6.94	2.23	22.22	0.00	5.56	1.92	1.92	5.00
Prismatic Change	8.42	24.00	0.00	0.00	6.94	3.35	0.00	0.00	2.78	7.05	10.58	0.00
Prismatic Alternate	1.05	4.00	0.00	0.00	9.72	1.68	0.00	0.00	2.78	5.13	3.85	20.00
Pyramidal Opposed	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78	1.92	0.00	0.00
Pyramidal Single	5.26	0.00	9.09	11.11	2.78	1.12	11.11	0.00	0.00	7.69	10.58	0.00
Pyramidal Change	9.47	0.00	0.00	5.56	2.78	0.00	0.00	0.00	0.00	5.13	4.81	0.00
Sub-naviform	2.11	0.00	9.09	0.00	11.11	4.47	0.00	0.00	0.00	1.28	1.92	5.00
Sub-naviform-tabular	0.00	0.00	0.00	5.56	0.00	6.70	0.00	0.00	2.78	1.92	0.96	5.00
Tabular Opposed	2.11	0.00	18.18	0.00	1.39	5.03	0.00	28.57	5.56	7.69	6.73	5.00
Tabular Single	2.11	0.00	0.00	0.00	2.78	10.06	0.00	0.00	11.11	6.41	7.69	5.00
Tabular Change	3.16	0.00	0.00	0.00	2.78	5.03	0.00	14.29	0.00	5.13	2.88	0.00
Tabular Alternate	2.11	0.00	0.00	0.00	6.94	5.03	0.00	0.00	2.78	2.56	0.96	0.00

The Early PPNB phase, J7 Phase I has a very distinctive range of core types (table 6.6). Virtually the full range of types defined in this analysis is present, a significant proportion of this range in low percentages. There is therefore considerable variety in strategy represented. The most important group is prismatic cores, of a variety of platform types and pyramidal cores are also important (figs. 6.1:2 and 4; 6.2:2). Naviform cores *sensu lato* are present (figs. 6.5:1; 6.6-6.8) but in low proportions (c. 9.5%) compared to 7th M.b.c PPNB occupations (table 6.6). If we look at broad patterns of strategy based on platform relationships it can be seen that single and change of orientation strategies (fig. 6.1) are important (over 50%) relative to opposed/alternate platform strategies compared to the 7th M.b.c. PPNB occupations (table 6.7).

At Middle PPNB J7 Phase II, even though small sample size argues caution, it can be suggested that naviforms (fig. 6.5:3) *sensu lato* are significantly more important than in the Early PPNB (table 6.6). Clearly, the relationship between opposed/alternate and change of orientation and single platform strategies has been changed in favour of the former (now over 50%). Notable, however, is a distinct component of prismatic change of orientation types (table 6.6). The possibility of Early PPNB residuals affecting the reconstruction must be taken into account. Small sample size could well explain the restricted range of types.

The problems with contexts J7B9a and J7Ab14a have been discussed elsewhere. In particular, the probability, that the upper part of the stratigraphy in J7 Area A contains many residuals and that the sample is thus mixed, must be reiterated (section 4.4.1) and may account for some of the prismatic, pyramidal and cobble cores in this context, specifically those of exotic red raw material. These contexts, are, however, quite likely to contain J7 Phase II assemblages (section 4.4.1), and, despite their problematic stratigraphic circumstances, the importance of naviform (*sensu lato*) core types and relative importance of opposed platform strategies may well reflect this, particularly when the possible residuals in J7Ab14a are taken into account as such.

Middle or Late PPNB J7 Phase III also has very significant proportions of naviform cores, although lower proportions (on a larger sample) than J7 Phase II (table 6.6). The second most important component of the Phase III assemblage is prismatic cores and there is good reason to believe a certain number of these are residuals. As with other 7th M.b.c. PPNB assemblages opposed/alternate platform strategies are significantly more important (c. 60%) than single and change of orientation strategies (table 6.7). A peculiar feature of the J7 Phase III assemblage is the importance of alternate platform strategies (table 6.6), underestimated in these figures because a number of the naviform and sub-naviform cores actually demonstrate alternate platform use. Prismatic and tabular alternate cores account for 14.64% of J7 Phase III cores. Only the Azraq 31 Late

Neolithic assemblage has comparable proportions of alternate platform cores on a sample of dubious size. The other feature of the Phase III core assemblage of note is the relatively high proportion of sub-naviform cores (table 6.6).

Middle PPNB J26 has a core assemblage with significant features of similarity to the J7 Phase III assemblage. Naviform and naviform-tabular cores, however, occur in higher proportions than those in the J7 Phase III assemblage. A more significant contrast between J26 and 7th M.b.c. J7 (thereby including Phases II and III and later phase contexts not specifically assigned to one or the other of these phases), however, seems to lie in the conspicuous role of naviform-tabular cores relative to naviform *sensu stricto* (table 6.6). In 7th M.b.c. J7 the ratio of naviform:naviform-tabular is over 3.5:1 whichever phases/contexts are considered. In J26 the ratio is almost 1:1. Sub-naviform cores *sensu lato* are as important as in the J7 Phase III assemblage, although the tabular edge variant is considerably more important on J26 (table 6.6). This importance of naviform-tabular and sub-naviform-tabular cores may be associated with the fact that other tabular edge cores (fig. 6.4:1 and 2) play a significant role in the J26 assemblage (table 6.6) and suggests that those responsible for naviform reduction on J26 were also involved in the other strategies. Given these contrasts with broadly coeval (although possibly earlier) J7 Phases II and (possibly coeval) III it is interesting to note the distinctions in size between 7th M.b.c naviform cores *sensu lato* and those from J26 (section 6.5.2). These accumulated distinctions suggest potentially behaviourally meaningful differences between the execution of the naviform strategy by the community on J26 as opposed to the community(ies) on 7th M.b.c. J7. Other core types occur in the same low proportions as J7 Phase III, for example, cobble types. Prismatic cores occur in lower proportions than on J7 Phase III but here Early PPNB residuals may be present. After naviform types *sensu lato*, tabular edge cores occur with most frequency (table 6.6). They are also a significant component of J7 Phase III (table 6.6). Alternate platform cores are not particularly important on J26. As with the other 7th M.b.c. PPNB assemblages opposed and alternate platform cores are considerably more important than single or change of orientation strategies. As with J7 Phase III opposed and alternate platform cores are c. 60% of the core assemblage (table 6.7).

The samples, from probably Middle, or possibly Late, PPNB J32 and Late PPNB Azraq 31, are far too small to draw any significant conclusions about proportions of different types (table 6.6). The only factor worthy of highlighting is the relative importance of naviforms *sensu lato* as with other 7th M.b.c. PPNB assemblages.

Dramatic differences are to be seen between the Middle and Late PPNB and the Late Neolithic assemblages. In what is probably the earliest Late Neolithic at Phase I J13 naviform and naviform-tabular cores are still present (fig. 6.5:2), but in relatively low proportions (table 6.6). These are unlikely to be residuals as no *in situ* PPNB occupation of significant size was hinted at on J13. The ratio of naviform to naviform-tabular is most akin to the situation on J26 (table 6.6). Sub-naviform-tabular cores are also present. For the first time since the 8th M.b.c. assemblage at J7 single/change of orientation strategies are more important than opposed/alternate strategies (table 6.7)(bar the very small-sized and probably mixed sample from J7Ab14a). Tabular and cobble cores are the most important, both 'opportunistic' in their exploitation of the raw material contours (table 6.6). The importance of tabular cores (particularly single platform types) is perhaps an indication of some further links with the J26 assemblage.

For the first time on a significantly sized sample edge of bifacial pieces make their appearance (table 6.6). They are a small but constant feature of the Late Neolithic assemblages in contrast to the PPNB core assemblages.

Prismatic and irregular core types occur in small but significant proportions (table 6.6).

With its low, but significant proportions of naviform cores (and perhaps tabular edge cores), the core assemblage from J13 Phase I can be judged as a genuinely transitional one, representing the declining continuity of old traditions alongside increasingly important new strategies.

In the later Phase on J13 (the C14 dates and stratigraphic evidence indicate a relatively short passage of time - section 4.4.5) there has been a further decline in the proportion of naviform cores present. It is quite possible that these few individuals are residual and that naviform strategies were no longer part of the production repertoire. Cobble, prismatic and tabular cores represent the dominant strategies with pyramidal cores almost as significant (table 6.6). Perhaps more indicative is the fact that single and change of orientation strategies now represent more than 50% of the core assemblage (table 6.7).

The most significant differences between J13 Phase I and II, apart from the virtual disappearance of naviforms, lie in the increase in prismatic cores and, perhaps more importantly, the dramatic rise in the proportion of pyramidal cores in Phase II (table 6.6).

Although not necessarily later than J13 Phase II the assemblage from J25 exemplifies the trends seen in the development from Phase I to Phase II at J13. Naviform and naviform-tabular cores are completely absent (table 6.6). Sub-naviform types are represented by a very low proportion of cores which were definitely not preformed like naviforms and therefore represent 'devolved' strategies.

Cobble cores clearly dominate the J25 repertoire (fig. 6.2:1; 6.3:1). However, prismatic, tabular and pyramidal (fig. 6.3:2) cores are approximately of the same importance as on J13 Phase II, with perhaps significantly, pyramidal cores being slightly more important (table 6.6).

Perhaps most dramatic is the extent to which single and change of orientation strategies dominate over opposed/alternate (table 6.7). In this and other regards (sections 6.7.1 and 6.9-6.10) the technology represented on J25 can be seen as the culmination of technological developments in the transition from the PPNB to the Late Neolithic.

It is difficult to place the Late Neolithic assemblage on Azraq 31 because of small sample size and the possible presence of residuals from the Late PPNB occupation. Thus naviform cores occur in low numbers (table 6.6). If they were genuine representatives of Late Neolithic technology, they might pertain to a production regime similar to that of the Early Phase on J13. They could, all too easily, be residual. Other features of the material culture of Late Neolithic Azraq 31 are very reminiscent of J13 Phase I so we must allow the possibility that the naviforms are genuine components of the assemblage. They do occur in lower proportions than in Late PPNB Azraq 31 (table 6.6).

The most striking feature of the assemblage is the significant number of edge of bifacials (table 6.6)(fig. 6.4:3).

The importance of opposed and alternate platform cores, including 2 sub-naviform cores and 4 prismatic alternate cores (not encountered in Late PPNB deposits at Azraq 31), relative to single and change of orientation types in this Late Neolithic setting (table 6.7), must give pause for thought and might argue a relatively early chronological position for the assemblage (an argument possible on other grounds). However, clearly we cannot provide any conclusive arguments based on this evidence.

Table 6.7. Proportions of opposed/alternate platform cores compared to single/change of orientation cores at the Azraq Project Neolithic sites.

	J7 I	J7 II	J7B9a	J7Ab14a	J7 III	J26
Opposed/alternate	32.63%	56.00%	72.73%	22.22%	59.72%	63.69%
Single/change	52.63%	36.00%	27.27%	44.44%	27.78%	25.14%

	J32	A31 I	J13 I	J13 II	J25	A31 II
Opposed/alternate	44.44%	57.14%	30.56%	34.62%	15.38%	50.00%
Single/change	33.33%	14.29%	41.67%	53.21%	67.31%	10.00%

There are some interesting analogies between the situation in the Early PPNB and the Late Neolithic in Jilat in terms of production technology. These emphasize the importance of the dichotomy between opposed/alternate and single and change of orientation strategies. In the 8th M.b.c. assemblage cobble and pyramidal cores are relatively more frequent than in the 7th M.b.c. assemblages (excluding the problematic small single context samples). When single and change of orientation strategies again become important in the early 6th M.b.c. cobble and pyramidal cores become important as well (table 6.7). There are contrasts, however. One major one lies in the much greater significance of the opportunistic tabular and cobble strategies in the 6th M.b.c. compared to the 8th. and the greater importance of the prismatic cores in the 8th M.b.c. These prismatic cores appear to reflect a more systematic intensive reduction as do the pyramidal cores of the 8th M.b.c., in contrast to the pyramidal cores of the 6th M.b.c. which are closely related to cobble types.

Section 6.5.2. Core size; variability through time.

The naviform cores are clearly a very homogeneous group compared to other core types in terms of their size. It is therefore of particular interest to see whether there are significant chronological or inter-site differences within the naviform core group. A plot of length against width of all naviforms *sensu lato* and sub-naviform cores (fig. 6.52) that were part of the detailed attribute analysis indicates the considerable degree of size overlap between the cores of these types regardless of site or period. In particular it should be noted that the 8th M.b.c Early PPNB naviforms (this is true for naviforms *sensu lato* and *sensu stricto*) overlap completely with the distribution of 7th M.b.c. and that the Azraq 31 cores overlap completely with those from Jilat (fig. 6.52). There are some hints of distinctions between the larger samples from the 7th M.b.c. occupations. In particular the bulk of the J26 cores seem wider than the bulk of the J7 Phase II and III cores (fig. 6.52) and the admittedly small sample of J32 cores. There are also hints of a further distinction between J7 Phase II and Phase III cores. A higher proportion of the former are longer than a similar proportion of the latter.

A considerable proportion of these smaller-sized cores are sub-naviform, however (fig. 6.53). If the size distributions of naviform and naviform-tabular cores are studied separately there is still evidence of distinctions in width between J26 and J7 Phase II and III cores; a higher proportion of the former are wider. A distinction, based on length, between J7 Phase II and J7 Phase III cores is less clear if the smaller J7 Phase III sub-naviforms are excluded from the analysis, but does hold if the naviform and naviform-tabular cores are considered together.

The evidence seems clear; there is an absence of broad regional or chronological trends in the variation of naviform core size. At least in Jilat and Azraq we are faced with a relatively homogeneous group of cores over considerable time spans. Those factors contributing to variation in core size, initial nodule size (in the case of Jilat preferred nodule size - section 6.6.2), preform size and preferred or required size of abandonment, seem to remain relatively constant in Jilat and apparently Azraq on the broad chronological and regional scale. The only variation detected relates to broadly coeval occupations in the Middle (and possibly into the Late) PPNB. J26 is likely to be coeval with at least one of the two relevant J7 occupations. In terms of strategies indicated by core types it is closest to that of J7 Phase III (also suggested by the tool assemblage - section 8.10). Given the extensive preparation and intensive reduction that most of these cores witnessed (section 6.3.2.5), variations in width of the cores are most likely to relate to variation in the character of the original preform and in particular its thickness. This variation is likely to be an indication of a different approach and possibly technique to preform preparation by different communities of knappers in the Wadi el-Jilat. Variations in length of naviforms will relate more to factors affecting abandonment of cores, either the size of required blanks or features considered to make the core not further workable or not suitable for rejuvenation. This point may have been reached later in the reduction of a naviform (*sensu lato*) during the J7 Phase III occupation.

The Early PPNB non-naviform cores show a quite different distribution on length:width scattergrams when compared to the later non-naviform cores (fig. 6.58). In the Early PPNB this group is the most significant part of the assemblage. The bulk of the cores are between 20 and 60 mm. in width and 10 and 60 mm. in length (figs. 6.1; 6.58). There are slight, but possibly significant, differences between the two Early PPNB contexts analyzed. There is a higher proportion of larger cores in J7C6a than in J7A34a (fig. 6.58). There were also more naviform cores in J7C6a. These larger cores from J7C6a consisted of the same types, in terms of shape, number and disposition of platforms, as the smaller cores from J7C6a and J7A34a.

The bulk of the 7th M.b.c. PPNB non-naviform cores from Jilat are longer and a notable proportion wider than the Early PPNB non-naviform cores. A significant proportion of the Early PPNB non-naviform cores are of the exotic red raw material which may account for the reduced size of these cores (fig. 6.1:3 and 4). However, a conspicuous proportion of these Early PPNB small cores is not (fig. 6.1:2). It seems likely that the small size of these Early PPNB non-naviform cores must relate to production strategies and that indeed the small size of the exotic red cores might well relate to the prevailing Early PPNB reduction strategies rather than to the nature of the raw material used.

The non-naviform cores from J7 Phase II contexts J7B29a and J7B33a were too few in number to observe significant trends in their size distributions (fig. 6.59). The cores from J7A14a are probably coeval, but there are potential problems of significant numbers of residuals in these later parts of the J7A stratigraphy (section 4.4.1). A consideration of the non-naviform cores from these three contexts together is useful in the light of the analyses of other 7th M.b.c. Jilat non-naviform core sizes. Just under half the J7A14a cores concerned fall into the same size range (length:width) as the Early PPNB non-naviform cores (fig. 6.59). It is tempting to view a significant proportion of these as residual. All these relatively small cores are single platform or change of orientation, mostly prismatic and pyramidal cores and half of them are of exotic red raw material. None of the larger non-naviform cores from J7Ab14a, J7B33a or J7B29a are of exotic red material and a different range of platform and shape classes are represented. The rest of the J7A14a and the bulk of the J7B33a and J7B29a non-naviform cores conform to a pattern similar to that of other 7th M.b.c non-naviform core assemblages. This pattern is that the greater proportion of cores are longer than 50 mm. and that these longer cores fall into two groups a narrower and a wider (fig. 6.59). The narrower are between 15 and 35 mm. wide and the wider 50 and 70 mm. wide. A significant proportion of the wider group are preforms from J7Ab14a as in the examples measured from J26A.

The non-naviform cores from Middle PPNB J26 clearly fall into this pattern (fig. 6.60). There are no cores under 40 mm. in length (fig. 6.4:1 and 2). The vast majority are over 60 mm. in length. The cores over 50 mm. in length fall into two clear width groups, one 15-35 mm. wide, a second 55-70 mm. wide (fig. 6.60). A significant proportion of this wider group is preforms as in the case of J7Ab14a. The groups do not seem to be otherwise distinguished.

The non-naviform cores from Middle or Late PPNB J7 Phase III show a contextually differentiated distribution (fig. 6.61). Most of those from J7B6a conform to the pattern indicated for J26 and probably J7 Phase II. Most cores are longer than 50 mm. and these relatively long cores fall into two groups based on width, the narrow group in this case is between 12 and 32 mm. wide and the wider group between 50 and 70 mm. wide (fig. 6.61). There is little overlap in the distributions of cores from J7B6a and from J7B11a (fig. 6.61). The latter are relatively small. In fact they overlap considerably with the Early PPNB cores from J7 (fig. 6.58). A number are of exotic red material and of the same shape (prismatic and pyramidal) and platform types - a considerable number are change of orientation types relatively rare among the longer cores - as found in the Early PPNB levels. It is likely that a significant number of the cores in J7B11a and some in J7B6a are residual as with the points (section 4.4.1 and table 4.1).

The non-naviform cores from Azraq 31 Late Neolithic contexts provide a well defined contrast with the observed pattern of 7th M.b.c. cores from Jilat (fig. 6.62). There appear to be two groups of Late Neolithic non-naviform cores (fig. 6.62). There is a slightly larger group of smaller cores. Most of this first group are between 20 and 60 mm. long and 5 and 30 mm. wide. The second group is between 60 and 80 mm. long and 35-65 mm. wide. The contrasts are very clear; the group of smaller cores are narrower than most small Early PPNB cores and the group of larger cores fall directly in the size range poorly represented by 7th M.b.c. non-naviform cores. The group of smaller cores are mostly tabular edge types of tabular raw material. The group of larger cores have a more heterogeneous range of shape and raw material types, although a significant proportion are either prismatic or edge of bifacials (fig. 6.4:3). It is also noteworthy that half of this group of larger cores make up the bulk of cores from one context A31C15a. The Late PPNB non-naviform cores from Azraq 31 are too few to regard their status relative to the Late Neolithic cores of great significance (fig. 6.62). It is worth noting in the light of other similarities between the PPNB and Late Neolithic assemblages and contrasts with Jilat assemblages, in particular aspects of their technology, that these PPNB cores seem to fall into the Azraq 31 Late Neolithic size ranges rather than the patterns of the 7th M.b.c. cores from Jilat.

The Late Neolithic non-naviform cores measured from Jilat were unfortunately few and belong to the Early Phase on J13 (fig. 6.62). These cores are suggestive of the pattern for 7th M.b.c. non-naviform cores from Jilat, 5 of the 6 cores are over 60 mm. in length (fig. 6.62). It should be noted that 2 fall into the size range of the group of larger cores from Azraq 31 Late Neolithic contexts.

The reasons for these variations in size are not all necessarily linked to factors we have controlled for and can thus effectively investigate. The small size of the Early PPNB (fig. 6.58) cores is not completely linked to an intensive use of ‘expensive’ exotic red material, although this may be one factor; it must relate to the aims and strategies involved. Required blank size is clearly one factor. The evidence is strong that bladelets were desired blanks (sections 6.7.1 and 6.7.2). Strategies were employed which encouraged the production of relatively small, fine elongated blanks and which thus promoted the by-production of small cores (fig. 6.1) in the maximisation of bladelet production.

Preferred blank size may be an important part of the 7th M.b.c. pattern. Whatever the width of the cores most, not thought to be possible residuals, are over 55 mm. in length. Perhaps significantly the naviform cores fall into the size range of the long narrow group of 7th M.b.c. cores, although the non-naviform cores may have a slightly narrower mean width. Perhaps once core size dropped much below 55 mm. removals of desired length could no longer be produced with consistency. When the cores are classified by removal type (table 6.8) all the 7th M.b.c. assemblages have a very similar and relatively high proportion of blade and blade/bladelet cores, c. 50% to just over 60%. This emphasizes the homogeneity of the 7th M.b.c. assemblages in this regard as in the size of cores and the importance of blade production (sections 6.7.1 and 6.7.2). Cores shorter than this may represent different production ends or particularly intensive or effective production episodes.

The situation at Late Neolithic Azraq 31 may reflect a desire for different removal types from that witnessed in the 7th M.b.c. and/or by Jilat communities. Certainly cores dominated by flake removals are more common at Late Neolithic Azraq 31 than on 7th M.b.c. Jilat sites (table 6.8). That it may not be purely chronological factors at play is suggested by the earliest Late Neolithic cores from J13, almost all over 60 mm. in length. Further, the admittedly small number of non-naviform PPNB cores from Azraq 31 are below 55 mm. in length. Most naviforms, PPN and Late Neolithic from Azraq 31 are over 55 mm. long. Other aspects of technology, notably technique, are different at Azraq 31 (section 6.8.4). They may possibly relate to the different degree of raw material availability or to broader behavioural matters.

Summary.

Perhaps one of the most notable factors is the contrast between the naviform *sensu lato* and non-naviform cores in terms of variation in size through time. There are distinct differences between the sizes of the cores of the 8th, 7th and 6th M.b.c. non-naviform core assemblages. There are no such clear chronological and/or regional distinctions between the naviform cores. Various factors point to the maintenance of a strong and coherent tradition of naviform core production over an extensive time period and a significant area, whatever the degree to which differing requirements, probably mostly for different blank types, affected the rest of the production industry.

Section 6.5.3. Debitage types of all cores; variability through time.

Table 6.8. numbers and percentages of debitage types of cores; variability through time.

Table 6.8a

		Cores blank types			
	Blade/bladelet	Bladelet	Flake	Mixed	Total
J7I	40	9	30	20	99
J7II	15	1	4	5	25
J7B9a	8	0	3	0	11
J7A14	6	2	6	4	18
J7III	38	6	13	18	75
J26A	30	3	14	3	50
J26B	58	7	12	21	98
J26C	22	0	4	6	32
J26 total	110	10	30	30	180
J32	5	1	1	1	8
A31PPN	4	0	2	1	7
J13I	8	5	15	8	36
J13II	45	8	16	18	87
J25	27	4	36	37	104
A31LN	12	3	7	2	24

Table 6.8b

	Blade/bladelet	Bladelet	Flake	Mixed
	%	%	%	%
J7I	40.40	9.09	30.30	20.20
J7II	60.00	4.00	16.00	20.00
J7B9a	72.72	0.00	27.27	0.00
J7A14	33.33	11.11	33.33	22.22
J7III	50.67	8.00	17.33	24.00
J26A	60.00	6.00	28.00	6.00
J26B	59.18	7.14	12.24	21.43
J26C	68.75	0.00	12.50	18.75
J26 total	61.11	5.56	16.67	16.67
J32	62.50	12.50	12.50	12.50
A31PPN	57.14	0.00	28.57	14.29
J13I	22.22	13.89	41.67	22.22
J13II	51.72	9.20	18.39	20.69
J25	25.97	3.85	34.62	35.58
A31LN	50.00	12.5	29.17	8.33

Blade and blade and bladelet cores occur in relatively constant proportions in all 7th M.b.c. occupations (table 6.8). Their proportions are between c. 50 and just over 60% (table 6.8). They occur in slightly lower proportions in the Early PPNB. They occur in proportions comparable to those of the 7th M.b.c. in two 6th M.b.c. occupations, J13

Phase II and Azraq 31. On two Late Neolithic occupations, however, they occur in significantly lower proportions (table 6.8). On Early Phase J13 and J25 they occur as between 20 and 25% of cores.

Cores which ended their lives producing only bladelets occur in much lower but variable proportions from Early PPNB to Late Neolithic, between c. 3 and 14% (table 6.8). It is notable that bladelet cores are most frequent in the earliest Late Neolithic occupation when blade/bladelet cores are relatively less common (table 6.8).

Cores for flakes occur with relatively regular and somewhat greater frequency on 7th M.b.c. occupations in Jilat than bladelet cores, between c. 12 and 20% (table 6.8). Cores for flakes occur significantly more frequently on Early PPNB J7 and three of the four Late Neolithic occupations, c. 30% - just over 40%. The Late Neolithic occupation that is an exception to the others in this regard is Phase II on J13, where cores for flakes occur in the same range as on 7th M.b.c. Jilat sites (table 6.8). As we will see there are some indications particularly from platform sizes that the techniques employed on J13 Phase II were more akin to those of the 7th M.b.c. than on J13 Phase I or J25 (section 6.8.2-6.8.4)

Summary.

The homogeneity of the 7th M.b.c. core assemblages in regard to removal type is informative. It seems clear flake production became a more important if not an invariable part of Late Neolithic industries. It is perhaps significant that the frequency of cores for flakes is higher in the Early PPNB when single and change of orientation strategies are relatively important as in the 6th M.b.c. assemblages (section 6.5.1). Variation in strategy and technique in the 7th M.b.c. is unlikely to be ascribed to variation in basic blank type production on this evidence. Within these categories there might be considerable variability in the blanks produced. Such variability might well relate to strategy-technique factors. Further discussion is best deferred until the removals themselves are considered.

Section 6.5.4. Platform preparation (section 6.2.15); variability through time.

Table 6.9. Numbers and percentages of cores with various platform characteristics in each occupation.

Table 6.9a

Naviform platforms

	Removal surface	Fine	Coarse	Cortex	Plain	Total cores
J7I	8	4	3	2	11	11
J7II	5	4	3	1	8	11
J7B9	2	1	3	0	6	6
J7A14	2	0	2	0	4	4
J7III	10	13	13	2	19	36
J26A	5	3	7	2	16	23
J26B	22	10	6	3	43	47
J26C	8	5	4	2	15	17
J32	1	1	2	0	2	4
A31PPN	0	1	3	0	3	3
J13I	2	1	3	0	6	6
J13II	5	0	2	1	10	10
J25	1	0	0	1	3	3
A31LN	1	0	1	0	4	4
	Non-naviform platforms					
J7I	9	8	13	31	57	84
J7II	3	7	1	6	7	14
J7B9	1	1	1	1	4	5
J7A14	0	2	2	6	10	14
J7III	5	10	8	19	31	46
J26A	0	6	3	12	9	27
J26B	7	7	8	17	42	51
J26C	0	2	2	8	10	17
J32	0	0	0	2	2	5
A31PPN	0	0	0	1	2	5
J13I	1	5	2	14	24	30
J13II	20	15	5	61	107	141
J25	7	11	5	47	64	101
A31LN	0	0	6	3	15	16

Table 6.9b

	Naviform platforms				
	Removal surface %	Fine %	Coarse %	Cortex %	Plain %
J7I	72.72	36.36	27.27	18.18	100.00
J7II	45.45	36.36	27.27	9.09	72.72
J7B9	33.33	16.67	50.00	0.00	100.00
J7A14	50.00	0.00	50.00	0.00	100.00
J7III	27.77	36.11	36.11	5.55	52.77
J26A	21.74	13.04	30.43	8.70	69.57
J26B	46.81	21.28	12.77	6.38	91.49
J26C	47.06	29.41	23.52	11.76	88.24
J32	25.00	25.00	50.00	0.00	50.00
A31PPN	0.00	33.33	100.00	0.00	100.00
J13I	33.33	16.67	50.00	0.00	100.00
J13II	50.00	0.00	20.00	10.00	100.00
J25	33.33	0.00	0.00	33.33	100.00
A31LN	25.00	0.00	25.00	0.00	100.00
	Non naviform platforms				
J7I	10.71	9.52	15.48	36.90	67.86
J7II	21.43	50.00	7.14	42.86	50.00
J7B9	20.00	20.00	20.00	20.00	80.00
J7A14	0.00	14.29	14.29	42.86	71.43
J7III	10.86	21.74	17.39	41.30	67.39
J26A	0.00	22.22	11.11	44.44	33.33
J26B	13.73	13.72	15.69	33.33	82.35
J26C	0.00	11.76	11.76	47.06	58.82
J32	0.00	0.00	0.00	40.00	40.00
A31PPN	0.00	0.00	0.00	20.00	40.00
J13I	3.33	16.67	6.67	46.67	80.00
J13II	14.184	10.64	3.55	43.26	75.89
J25	6.93	10.89	4.95	46.53	63.37
A31LN	0.00	0.00	37.50	18.75	93.75

Table 6.9 illustrates several important facts. Preparation of the platform edge on the main removal surface of naviform cores *sensu lato* (figs. 6.5:1 and 3; 6.7; 6.8) was relatively common in all periods. There was no more variability in the proportions of cores with this type of platform preparation between coeval occupations, or between different parts of sites occupied during the same phase, than there is through time. Further, to the extent that these or related core types persist into the Late Neolithic, many as sub-naviform variants, such preparation occurs only marginally less frequently - if at all less frequently - than in earlier assemblages (table 6.9). Such facetting always occurs more frequently, usually considerably more frequently - on naviform cores than on contemporary non-naviform cores, regardless of period (table 6.9). On naviform

cores *sensu lato* preparation of the main removal surface adjacent to the platform was almost (the one exception is J7 Phase III, table 6.9) always more important than fine facetting on striking platforms themselves (fig. 6.4:1) and usually more important than more extensive irregular flaking of striking platforms (fig. 6.4:1). The relationship between fine facetting on striking platforms of naviform and contemporary non-naviform cores is variable from period to period (table 6.9). Coarse facetting of striking platforms is more common on naviforms, but with some notable exceptions. On the whole naviform strategy and technique are thus relatively uniform and consistently segregated from other strategy-technique combinations from the mid/late 8th M.b.c. into the early 6th M.b.c. in these as in several other attributes.

In the Early PPNB preparation of the main removal surface on the edge of the platform on naviforms (figs. 6.5:1; 6.7; 6.8) occurs with particular frequency (although the sample is small) - this provides a notable contrast with contemporary non-naviform cores (table 6.9). Nevertheless, the frequency of preparation of the main removal surface in the Early PPNB compares closely with that in several later occupations, namely J7 Phase III, J26 if the occupation at the site is treated as a single chronological entity, J13 Phase II and J25. The only occupation with conspicuously higher frequencies of non-naviform main removal surface preparation is J7 Phase II which has a rather small sample (even when J7B9a is included as might be appropriate). In a number of instances main removal surface preparation is conspicuously absent or occurs only in low proportions (table 6.9). One of the most notable instances of this is J26, where in broadly contemporary sequences from three trenches (Areas A, B, and C), there exists a distinct dichotomy between the application of this sort of preparation to non-naviform core platform edges. It is absent from J26A and C, occurring relatively frequently - relative to other occupations - in J26B (table 6.9). Sample size cannot provide a complete explanation here as the combined total of non-naviform cores from J26A and C is close to that from

J26B In this case, at least, it seems related to a similar contrast in the case of the naviform cores. Here such preparation is relatively infrequent - relative to the other trenches - in J26A. Chronology seems unlikely to be a factor in the homogeneous assemblage from J26 where we are dealing with sequences of occupation deposits from each trench. It seems likely that in this case, at least, we have some indication of variability in knapping at the sub-community level (i.e. between groups or individuals belonging to the same community or change in behaviour by the same groups/individuals) finding expression in spatially discrete samples presumably as a reflection of spatially discrete locales of production and deposition.

In other instances variation in the preparation of the edge of the main removal surface of non-naviforms is clearly not related to the relative degree of preparation (relative to other occupations) on naviforms or indeed the relative importance of the naviform method itself. Thus in J7 Phase III when such preparation is at its least important (apart from at Azraq) on naviforms, it is relatively significant on non-naviforms. In the earliest Late Neolithic on J13, a technologically, typologically and chronologically transitional assemblage where full blown naviform strategy remains a still significant if small part of production (section 6.5.1), such preparation is relatively uncommon on non-naviforms. Yet in later phase J13 where it is questionable whether true naviform production is still carried out, main removal surface preparation is significantly more common on non-naviforms than during J13 Phase I. It seems probable then that variation in frequency of this preparation is likely to be a sensitive reflection of community or (as J26 suggests) sub-community knapping practice and, potentially, tradition.

Such a tradition may be present at Azraq 31 from Late PPNB to Late Neolithic. Here such preparation is very rare on both non-naviform and naviform cores, although sample size is highly problematic (1 instance with removal surface preparation out of 28 cores)(table 6.9). Yet on similarly sized samples in Jilat there are significant numbers with preparation, particularly, of course, naviforms. If this distinction can be taken at face value, it may be one further indication of rather different continuous, coeval production traditions operating in two contiguous geographical regions (sections 6.9-6.10). As we will see the blade-bladelets from Azraq 31 have much higher frequencies of preparation of the edge of the platform than indicated by cores or than any blade-bladelet occupation samples from Jilat (sections 6.8.2 and 6.8.4). This suggests not only significant contrasts between the traditions of production evidenced in Jilat and Azraq but that a proportion of blade-bladelets from the Azraq 31 samples may not have been produced from the sort cores represented in the Azraq 31 sample.

Fine preparation of the striking platform is relatively constant on naviforms *sensu lato* through all major phase samples on J7 - in contrast to preparation of the main removal surface - it occurs on about a third of cores (table 6.9). It occurs more frequently than in any of the J26 trenches. Its mean occurrence on J26 is notably lower, between a quarter and a fifth of all naviforms analysed on J26 have fine preparation of the striking platform. Given that J26 is coeval with one of the later J7 phases this may be taken as a further indication of community level variation in behaviour relating to naviform production. That such factors are at work on the sub-community level is suggested by the low frequency with which such preparation occurs in J26A, also of course where preparation of the main removal surface was less frequent.

It occurs in lower proportions in J13 Phase I than on earlier sites and is absent from naviforms *sensu lato* in J13 Phase II, J25 and Azraq 31 Phase II (table 6.9). Although the samples are small from these sites and we suspect regional variation as a factor explaining some of the differences between Azraq and Jilat sites, it is possible that there may be a trend in which fine facetting of the striking platform declines as the naviform strategy itself declines. It may, therefore, have been a less integral part of the strategy-technique combination than removal surface preparation which continues to be relatively important.

Frequently fine facetting was more common on non-naviforms than was preparation of the main removal surface (table 6.9). Only on J13 Phase II was it less common by a significant but small margin. Azraq 31 PPNB and Late Neolithic stand out because fine facetting is absent from non-naviforms as is preparation of the main removal surface and as it is from Azraq 31 Late Neolithic naviforms *sensu lato*. It occurs in low but significant proportions on coeval Late Neolithic sites in Jilat and (often in slightly higher proportions) on other 7th M.b.c. sites in Jilat (table 6.9).

Fine facetting of the striking platform is relatively infrequent in the 8th M.b.c. non-naviform sample compared to most later, 7th M.b.c. samples (table 6.9). It is also significantly lower than on contemporary naviforms as was facetting of the main removal surfaces of non-naviforms compared to contemporary naviforms. On 7th M.b.c. J7 it occurs with a higher frequency than in the Early PPNB and with a distinctly higher frequency than does removal surface preparation of contemporary non-naviform cores (table 6.9). It occurs notably more frequently than at coeval J26, further distinguishing these two production industries. As with other forms of platform preparation the J26A sample is unlike the cores from the other J26 trenches. On naviforms fine and removal surface preparation, and on non-naviforms fine facetting, were less common in J26A. On non-naviforms from J26A fine facetting is conspicuously more common than on similar cores from J26B and C.

Non-naviforms are the main core types on J13 and J25. It is interesting that fine platform preparation occurs with about the same frequency on J25 and J13 Phase II, whilst it is slightly higher in J13 Phase I (table 6.9).

There is no clear relationship between coarse and fine platform facetting on naviform or non-naviform cores and no clear trends through time.

Coarse facetting is usually more common on naviforms than non-naviforms through all periods (table 6.9). The exceptions are Azraq 31 Late Neolithic (and J26B if the trenches on J26 are given separate consideration). Azraq stands apart from the Jilat sites with relatively high frequencies of coarse facetting on both naviform and non-naviform cores of Late Neolithic and naviform PPN cores. It is particularly significant in two ways: 1) in comparison with the very sporadic removal surface and fine facetting on the Azraq 31 cores and 2) in comparison with coeval Late Neolithic non-naviform cores from Jilat. This seems to be a further indication of the distinctiveness of Azraq 31 production technology.

A significant proportion, ranging between c. 20 and 50% of naviform cores, have coarse facetting at all periods (table 6.9). Interestingly naviform strategy-technique on J26A is further distinct; naviform cores from this trench with the lowest proportions of removal surface and fine platform facetting have the highest frequency of coarse facetting on J26 (table 6.9).

The other significant variability reflected by coarse facetting is the contrast between non-naviforms and naviforms at J13, coarse facetting is high on the latter relative to the former compared to other occupations. Indeed, coarse facetting of non-naviform cores is relatively infrequent in the Early Late Neolithic in Jilat (table 6.9).

The frequency of cortical platforms is low and randomly variable through time on naviforms as might be expected (section 6.3.2.1 and 6.3.2.7). The proportion of non-naviform cores with cortical platforms, between 35 and 47% of cores, is remarkably constant through time in Jilat. It is significantly lower at Azraq 31 in both PPN and Late Neolithic, a further illustration of the regional contrasts in production within the Azraq basin (sections 6.9-6.10).

Summary.

Preparation of the main removal surface on the platform edge and fine facetting of the striking platform edge isolate small areas of the platform as better defined targets for impactors, change the nature of the contact between impactor and platform - particularly the fine facetting of the platform itself - and alter the platform angle. Preparation of the main removal surface removes spurs left by negatives of previous removals that might misguide removals. Coarse facetting of the platform will affect mainly the platform angle rather than the other factors mentioned. Preparation is thus likely to be technique oriented, although quite possibly strategy related as the contrasts between naviform and non-naviform cores suggest.

It was obviously an important part of naviform production that the target area for the impactor was well defined and that removals were produced in a relatively directed fashion. Maintaining the main removal surface in a particular state was clearly important, not surprising given the investment in creating it. Obtaining a suitable platform angle was also important as the conspicuous frequency of all three preparation types on naviforms indicate, but particularly coarse facetting. Modifying the nature of the point of impact was also important. Generally naviform cores have high degrees of investment as witnessed by preparation in maintaining effective production compared to non-naviform cores. Given that this preparation is most likely to relate to aspects of technique, it seems quite probable that the distinct patterns of preparation witnessed by naviform cores may reflect the practice of distinct technique(s) compared to non-naviform cores. Discussion of this must be related to the removals themselves. Usually core type, from which debitage was removed, cannot definitively be attested but factors such as frequency of removal surface preparation on blanks may help determine whether they relate to naviform production (sections 6.8.2 and 6.8.4).

Clearly the importance of targetting precise areas for the impactor and minimising the risks of misguided removals was a much less important part of non-naviform production strategies and techniques than naviform. In the 7th M.b.c. maximising appropriate platform angles was relatively important on non-naviforms and modifying the area of impact may have had a role on non-naviforms. All these benefits of preparation appear to be less important in the Early Late Neolithic in Jilat. In short, there is less investment in non-naviform core production than naviform and declining investment in non-naviform production from 7th to 6th M.b.c. in Jilat. At Azraq there appears less investment in naviform or non-naviform strategies in both Late PPNB and Late Neolithic than in Jilat and very little indeed in specifically targeting or modifying impact areas. Coarse facetting is the only preparation that has any importance on naviform or non-naviform in PPNB or Late Neolithic at Azraq, which suggests preparation was aimed specifically at maximising appropriate platform angles.

Section 6.5.5. Platform angles; variability between occupations.

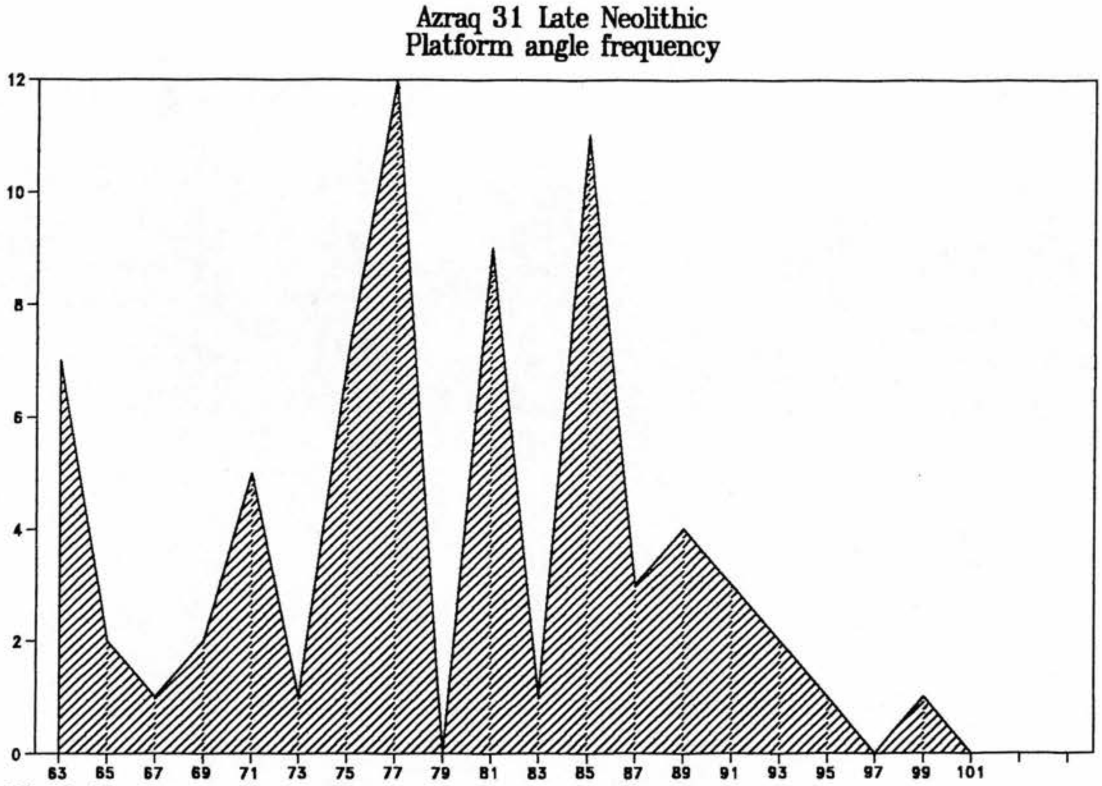


Fig. 6.63.

This difference in preparation between Azraq and Jilat, which may relate to different interest in platform angles, may be reflected in the very different distribution of angles from various occupations with significant measured samples. The sample of platforms, naviform and non-naviform (the distinction under examination cross-cuts these categories to some extent), from both periods at Azraq 31 shows a relatively dramatic bimodal distribution with few platform angles between 77° and 79° and high frequencies between c. 69°-77° and 79°-85° (fig. 6.63). No such distributions are apparent in samples from J7 Early PPNB (fig. 6.64), J26 (fig. 6.65), J7 Phase II (fig. 6.66), or J7 Phase III (fig. 6.67). It is pertinent to note, however, that all these samples do or might belong to earlier periods than those from Azraq 31. Other occupations are represented by samples too small to utilize.

Section 6.5.6. Crests (section 6.2.6).

It has been suggested by Calley (1986b) that the location of crests relative to the main removal surface on naviforms might be a temporally sensitive attribute. This would suggest distinctive changes in preform character through time. In fact there is no indications of any distinct temporal developments in the frequency of occurrence of particular crest locations relative to the main removal surfaces on Jilat/Azraq naviforms (appendix 2). Similar situations pertain in each naviform sample (*sensu lato*) from each occupation.

Section 6.6 Raw material use and procurement.

Section 6.6.1 The importance of raw material in assemblage characterization and interpretation.

A key factor in studying variation in chipped stone assemblages, in particular their technology, must be variation in raw material used. No resources of any type are evenly distributed across landscapes. Therefore varying availability of resources will play its role. Availability cannot, however, be viewed merely as the location of a resource in the physical landscape. There is, as well, a socio-economic dimension to availability. This involves the potentially variable willingness or ability of communities to expend effort/energy, directly or indirectly (exchange), on the procurement of particular raw materials. Preference for particular material types may therefore be an important consideration as one aspect of the socio-economic facet of availability. One aspect of preference will be the suitability of particular raw materials for the strategies and techniques of particular manufacturers; others might include aesthetic or ideologically inspired value judgements.

It seems important to establish both dimensions of availability if possible. To do this it is obviously essential to distinguish clearly any discrete raw material types and document as precisely as possible their occurrence in the landscape. The ability to relate the sources to the types actually encountered in the prehistoric assemblages is vital.

Having documented discrete material types encountered in Jilat and Azraq Neolithic assemblages, we can outline the distribution of the various raw material sources across the landscape in relation to the sites. We can thus document the options knappers had for raw material acquisition. By comparing acquisition patterns with availability we can assess whether acquisition was directed or possibly directed/possibly random and thus search for factors which may have produced any choices evidenced. In order that one can extrapolate from present day observations of raw material distribution to availability in the past, certain factors must hold good. To document truly past availability and choice we must be sure we have identified the location of all proximate sources and the sources of all the most important materials used on sites. We must be sure no sources have been significantly altered i.e. disappeared, appeared, become significantly more or less abundant. As might be appreciated our ability to satisfy these conditions in most areas is very difficult. Vegetation, geomorphological processes, and human activity serve to mask or remove or reduce sources whilst many significant sources are located at some distance from sites making difficult the task of systematically identifying all key sources.

In Jilat we have what is perhaps a relatively unique opportunity to satisfy all conditions. The reasons for this are basically 1) the abundance of suitable raw material sources in Wadi Jilat and their proximity to the sites;
2) the visibility of material sources in this desert environment lacking significant vegetational or soil cover;

3) the absence of holocene depositional or erosional events of the order to mask or remove sources;

4) the permanent or predictable character of the sources in the relevant geological and geomorphological terms (see below);

5) our consequent ability to determine fairly precisely the distance of sites from sources;

6) the ability to make significant distinctions in raw material type applicable to the archaeological material on an extensive scale.

Section 6.6.2 Raw material sources (section 6.2.9).

An extensive survey of all sorts of material sources led to a good understanding of the range of material variation and an ability to map specific sources in the wadi and relate them to the materials used on sites. The survey consisted in walking the whole length of the main wadi and all tributary stream beds regularly inspecting the raw material located therein. Transects were then walked perpendicular to the axis of the main wadi from hill top across the slopes and valley floor to hill top. These transects were more closely spaced around the concentration of Neolithic sites between J26 and J23 (fig. 3.4). They were walked c. 50 m. apart in this area. Further up and down stream transects were walked 100-200 m. apart. In addition two transects were walked along the length of the north and south valley slopes (fig. 3.4), one just below the crest and one lower down the slopes.

The basic distinction between wadi-rolled cobbles and untransported tabular material can be applied consistently and to a large body of the archaeological material and raw material in the field. The latter material is highly characteristic and it appears by an inspection of wadi material that transport, in even the smallest tributary wadis, soon damages the cortical surfaces and alters the patina on the edge of the tablets (section

6.2.9). In fact the bulk of the material from the wadis consists of distinct rolled cobbles without any of the classic cortical surfaces of tabular pieces. The other category of material recovered from Jilat sites was nodules untransported in wadis; this was found almost exclusively at J32 with only occasional pieces recovered from J7 (fig. 3.4). Whilst distinctive from wadi material in raw and slightly reduced form, it might be possible to confuse this material and wadi material on the smaller products of the reduction sequence. When dealing with the evidence from sites no attempt was made to systematically use a distinction between nodule and wadi-cobble material; they were treated as a group in analyses. The occurrence of the nodular source and rarity of the nodular material, as far as could be established, outside of J32 justified this. In making this vital distinction in the archaeological material between Jilat wadi/nodular and tabular material it was felt colour distinctions were not an accurate enough criterion; there was too much overlap in colour and texture ranges. Only those pieces with substantial enough areas of cortex preserved could be assigned to one or other category with certainty. In practice 20-30 mm. continuous cortex was considered enough area to determine whether the piece originated from wadi/nodular or tabular flint.

Three main outcrops of tabular flint, whose material corresponds closely to that used on the sites, were surveyed. An extensive sequence of outcropping beds extend from the gorge walls up through the slopes immediately east and south east of J7 on the south side of the gorge (fig. 3.4). These beds outcrop intermittently along the south side of the gorge for a distance of 300 m. east, downstream, to where they last outcrop opposite J24. A second, extensive set of outcropping beds extend up the hill slopes c. 500 m. to the south south west of J26 (fig. 3.4). A third set of beds outcrop where the wadi cuts the hillslope to its north, closer to the mouth of the Jilat, (about 5 km. to its west) and thus within a kilometre of J23 (fig. 3.4). A fourth set of outcrops are located on the hillslopes along the north side of the wadi north west of J6 opposite J25 and J13 (fig. 3.4).

However, the tabular flint here is of much poorer quality. It is darker material of coarser grain, much shattered, with many flaws and is completely unlike any material actually used on sites. There are no major outcrops of tabular flint, of similar quality to that used on the prehistoric sites in the main wadi of Jilat west of the outcrop to the south west of J26. In the three relevant outcrops beds of varying thicknesses are present, including the full range of thicknesses used on sites - documented by cores and tools - whether the 10-20 mm. thick slabs used for the tile kni~~f~~ves and bifacials or up to 120 mm. thick slabs (most commonly 20-60 mm. thick - figs. 6.5:2; 6.4:1 and 2; 6.6-6.8) which were used for flake/blade production. Material would be available in suitably sized slabs in abundance on and at the base of the slopes of these outcrops eroding from the beds, cracked by the extreme diurnal temperature variation of this steppe/desert environment. Whether exposed in the gorge or wadi edges or on the hillslopes the limestones, in which the beds are contained, erode faster than the beds themselves exposing large chunks to erosion and also a very simple quarrying method. With one or two blows at most, suitably sized slabs with completely unweathered surfaces can be easily detached from the parent outcrops. Material would thus have been easily available in abundance at these outcrops.

These tabular sources are fixed in the landscape. Their abundance or degree of exposure could not have been dramatically affected by gemorphological processes. Depending on the state of gorge formation and the precise location of the wadi fewer beds might have been exposed. There is circumstantial evidence that some sort of gorge system was probably formed by the Neolithic. To cloak the relatively steep slopes with soil and vegetation significant enough to mask the outcrops on the hillslopes would require a dramatically different climatic regime and for that there is no evidence (section 3.6).

The most problematic area is reconstruction of the prehistoric distribution of the wadi sources. By their very nature the wadi sources, viewed in broad perspective, are in a constant state of flux. They are subject to regular turn-over; presumably there is, at least from time to time, removal of material from the drainage system. A Roman dam (fig. 3.4) has blocked significant flow of the main wadi into the gorge adjacent to the sites and presumably the configuration of the main wadi and side wadis has changed somewhat in the past 11-8,000 years. To what extent can we look at the distribution of wadi sources today and understand their distribution in the past? There is always the possibility that the ultimate sources of material feeding the wadi cobble concentrations have changed. Inspection of the relationship between wadi material found at the sites and that recovered from the sources indicates that the material is visually identical in every way. It appears that the same sort of material is being deposited or has been recently deposited as in the several millennia over which the Neolithic sites were occupied. This is partly because some of the material, at least, derives from marsh deposits where it was deposited during the late Pleistocene. This is probably the source of the thin scatter of wadi material found in places on the valley floor.

Basically wadi cobbles, similar to those utilised on the sites, occur the length of the wadi from west of J32 to the mouth of the Jilat except in the stretch covered by the silts accumulated behind the Roman dam and the strip of gorge between the dam and J7 (fig. 3.4). This is presumably because the dam has blocked the main flow of cobbles and any material, that the two small tributaries adjacent to J13 and J25 (fig. 3.4) feed into the main wadi, is quickly flushed downstream or into the large cavities in the gorge bed. Adjacent to, and several hundred metres to the north east of, J7 (fig. 3.4) in the gorge there are abundant remnants of wadi cobbles today, exactly the same as those used on the site. Because of the deep hole immediately north of J7, which would block the flow of material from upstream, this concentration must either be a relict of a time when material could flow more freely through the system and (at least partly) the result of deposition from the tributary that runs past the south and east sides of J7 (fig. 3.4). It can safely be assumed that the course of the main wadi might have provided a significant quantity of cobbles adjacent to the sites of J26, J25 and J13 (fig. 3.4), as it does today further up and down stream of the dam. Even if this were not the case, a tributary immediately to the west of J25 (fig. 3.4) has a limited but significantly dense supply of such cobbles in its fill, as does a deeply incised tributary immediately to the east of J13. This latter stream bed swings around the foot of the hill with tabular outcrops to the south west of J26 and then swings south and east of J26 before turning northwards, emptying immediately east of J13 into the main wadi (fig. 3.4). This tributary, tapping as it does the tabular outcrops, has a higher proportion of modified tabular material than the other tributaries mentioned. It is clear from a systematic survey of this stream bed that transport only a few metres from the base of the outcrops significantly alters the original configuration of the tabular material. One other significant tributary source is worthy of mention. A relatively large stream bed runs north west-south east to the north east of J25 between J25 and J6 (fig. 3.4). Much of the material in this stream bed is modified tabular material with distinct light blue patina on its modified edges. East of the conjunction of this tributary and the main wadi much of this material is also found in the main wadi. This material is not similar to any used on the sites.

Nodular sources are rare. A small amount of the nodular material was found on the hillslope just south east of J7, but the only significant source was the hillslopes upon the lower part of which the site of J32 was located (fig. 3.4).

To summarise the position of choice in relation to each site in Jilat. All the sites may have had immediate access to some supplies of wadi cobbles. Given the picture provided by the adjacent tributaries, J13 and J25 certainly had immediate access to quantities of wadi cobble flint. In the case of J25 the quantities immediately available might have been slightly circumscribed, depending on whether the adjacent part of the main wadi contained concentrations of material. J7 had immediate access to abundant quantities of both types in the same adjacent setting. J26 had more immediate access to wadi flint, certainly in the tributary adjacent to J13 at a distance of 100 m.. at most, but also probably immediately adjacent in the main wadi. Two abundant tabular sources were equidistant at the greater distance of c. 500 m.. J32 is just under 3 km. from the closest source of appropriate abundant tabular flint, but both wadi and nodular flint are available in abundance, immediately adjacent to the site.

At Azraq the precise distribution of raw materials is not well understood. We are not in a position to satisfy all the conditions required to reconstruct the choices of prehistoric consumers. Landscape changes in and around the wetlands are likely to have occurred and may have masked proximate sources. Material found on the sites has not been successfully matched with specific sources unlike in Jilat. Given the distribution of flint in wadis and limestone outcrops in the general area, it is likely that material was available within a few km. of the site. For example, a sub-surface bed of tabular flint was observed 1.5 km. west of Azraq 31 near C spring (fig. 3.3) (Kirkbride 1989, 158), but it is not clear whether this would have been exposed during the Neolithic and it is not clear if it was of the same quality. Copeland (1989, 171) implies the presence of tabular flint close to Ain el Assad, which is between 2 and 2.5 km. west of Azraq 31. Such distances are however significantly greater than those between most sites and sources in Jilat.

Section 6.6.3 Procurement and raw material use strategies on Azraq Project Neolithic sites.

It remains to compare the actual procurement of raw material occupation by occupation with that immediately available in the light of reduction strategy preferences to assess procurement practices. It seems advisable to reconstruct preferences on the basis of proportions of cores of each material type because these provide an indication likely to be closer to actual raw material nodules procured than any measure based on proportions of debitage (table 6.10). The relative importance of raw material types in different debitage categories may relate as much to differing strategies, techniques, product requirements and intensity of production as applied differently to the various raw material types, as to proportions of each raw material originally procured.

Table 6.10. Raw material use by occupation.

	Wadi	Tabular	Exotic red	Exotic translucent
J7 Phase I	48	23	14	
J7 Phase II	10	13	1	
J7 Phase III	23	29	7	
J7Ab14a	7	5	2	
J26	30	136	1	4
J32	4	2		
J13 Phase I	11	20	1	
J13 Phase II	97	46	2	
J25	67	21	1	2
A31 PPNB	0	5		
A31 Late Neolithic	6	13		

It is argued here that in a raw material environment like that of Jilat preference for particular raw material types is exercised if extra effort is invested in their obtention. Binford (1979) has pointed out the manner in which raw material for chipped stone industries can be acquired during other activities, notably subsistence activities. Such embedded procurement removes extra costs from raw material acquisition because material is acquired as part of other necessary activities. There are two aspects to this, one that Binford does not consider, pertinent to the general situation, another to the situation in Jilat. As his informants suggested raw material was procured in lieu of the successful transaction of the activities into which it might be embedded as much as in addition to them, a recompense for lack of success, 'sensible men do not come home empty handed in the tundra'. Even such procurement is not costless, however. There is the relative cost of procuring one type of alternative resource as against another. The situation in Jilat is that raw material is embedded in site locations. The costs of procuring one material over another are minimal whether direct procurement or embedded procurement was practised. The issue is rather one of selectivity, in the assessment of which the possibility of extra effort required in transporting material small extra distances to sites may be relevant. Given the abundance of raw material adjacent to the sites it also casts a different perspective from that which normally pertains on sites where any material must be obtained from a distance. In these last situations, where any material must be transported over distance, the particular distances for transport may mean little in terms of relative energy expenditure when acquisition is embedded into other activities. When material is in abundance adjacent to sites there is always an extra cost in transporting material in any quantity over distance, if only the extra effort of carriage or the cost of not transporting another resource. In these circumstances if particular material types are imported over distance, it seems likely a certain degree of selectivity may be involved whether or not they were procured as part of an embedded procurement strategy.

If we compare the use of raw material on the different sites during the different phases, as attested by cores (tables 6.10 and 6.11), with the available resources the following becomes clear:

Table 6.11. Raw material use in relation to reduction strategies in each occupation.

Occupation	Wadi	Tabular	Exotic red	Exotic translucent
J7 Phase I				
Opposed	15	11	5	
Single	20	4	2	
Change	13	4	6	
J7 Phase II				
Opposed	1	5		
Single	1	1		
Change	2	1		
J7 Phase III				
Opposed	13	18	2	
Single	6	5	3	
Change	4	3	1	
J26				
Opposed	13	91	1	2
Single	10	18		
Change	4	13		
J32				
Opposed	1	1		
Single	3	1		
J13 Phase I				
Opposed	2	8		
Single	4	4	1	
Change	4	2	1	
J13 Phase II				
Opposed	24	25		
Single	31	7		
Change	34	7	1	
J25				
Opposed	5	5	1	
Single	21	7		
Change	30	4		1
Az31 PPNB				
Opposed		2		
Single		2		
Az31 Late Neolithic				
Opposed	4	6		
Single	2	4		

1) In the Early PPNB on J7 a pattern that differs significantly from an expected random use of local sources occurs. If random acquisition occurred from the adjacent sources, or sources in the general area, roughly equal proportions of tabular and wadi types might be expected. On this occupation wadi material outnumbers tabular by 2:1 (table 6.10). We have indicated that there is a general tendency for wadi material to be preferred for single platform and change of orientation cores (section 6.3.1.7). In this phase there is also an indication of the selective use of raw material. Thus, whilst tabular material is in the minority and opposed platform strategies are in the minority, tabular material dominates opposed platform cores (table 6.11). I would suggest that these are indications of the preferential selection of raw material to satisfy the needs of particular strategies. Because single and change of orientation strategies dominate reduction in the Early PPNB (table 6.7) wadi material dominates material acquisition. Clearly wadi material was used for opposed platform cores and tabular material for single and change of orientation cores, so these relationships reflect only preferences. The other notable feature is the relatively high proportion of exotic material exploited; exotic red material forms 16.5% of cores (table 6.10). Exotic translucent yellow material was also used but no cores were retrieved.

2) In phases II and III on J7 relatively similar situations of raw material use pertain. With only a slight predominance of tabular material procurement cannot be distinguished from the random acquisition of local raw material (table 6.10). On the other hand figures suggest some preference for the use of tabular material for opposed platforms (table 6.11) and particularly naviforms and wadi material for single and change of orientation strategies in both periods within the particular procurement environment (table 6.11). As in the Early PPNB some wadi material was used for opposed platform cores and some tabular material for single and change of orientation cores so these relationships do

reflect only preferences. Exotic red material occurs in lower proportions than in J7 Phase I and there are indications, particularly in core type and size, that many of these cores are residuals. There is, however, at least one exotic red material naviform and Byblos points occur occasionally made of this material in these phases, both good indicators that exotic red material continued to be used to limited extent in these periods.

3) The evidence from Middle PPNB J26 is unequivocal. In a situation where the most proximate and abundant sources were wadi cobbles, tabular flint dominates to a dramatic extent (table 6.10). Such an acquisition profile can only be seen as a result of selectivity probably involving extra efforts. On J26, where interest in tabular material was clearly so strong, tabular material even outnumbers wadi in single platform and change of orientation cores (table 6.11). However, wadi material is used disproportionately for these strategies, disproportionate that is to its overall frequency in the assemblage. I would suggest that procurement was clearly directed towards satisfying the needs of opposed platform production and that occasional single and change of orientation production then had to function in that procurement environment. A similar argument could probably be made for the situation on Early PPNB J7. Only very rarely was exotic red material obtained. Whilst exotics are relatively rare compared to J7, including the consideration of the obsidian recovered from J7 and not J26, an interest in exotic translucent yellow raw material is much more marked than on J7 (table 6.10).

4) At J32 an analogous, although dissimilar phenomenon, may exist. Here the very small core sample is dominated by local nodular material from the surrounding hillside but tabular raw material occurs in significant proportions (table 6.10). Whilst the small sample size may make conclusions suspect, the fact that a considerable interest existed in obtaining tabular material at some distance (c. 3 km.), when perfectly worthy local sources were available, can be attested by the relatively high proportion of CxF1's and

CxF2's amongst the cortical flakes (section 6.7.3). It seems clear that extra efforts must have been expended in procuring significant quantities of this material.

5) On J13 Phase I twice as much tabular as wadi material is present (table 6.10) in an environment where abundant wadi material is available immediately adjacent to the site and tabular material must be procured at a distance of c. 500 m. It seems extra efforts were expended on the procurement of tabular material and there is a clear preference for tabular material indicated by opposed platform cores (table 6.11).

6) In later Phase II on J13 there is a clear shift to the dominance of the acquisition of the immediately available wadi material (table 6.10). Extra effort was still taken to procure a significant quantity of tabular material whose use was favoured for opposed platform production (table 6.11).

7) At J25 a more extreme version of the pattern observed for J13 Phase II exists. Locally abundant wadi material completely dominates, some of it, in this case, of poorer quality, but an interest in tabular material is still maintained, procured probably with extra effort (table 6.10). Some of this tabular material is of different character from that normally encountered at the Jilat sources surveyed (section 6.2.9) or on the other sites. Some of the edges of these plaquettes have curved surfaces over which the white cortex continues, not the perpendicular brown patinated edges of the regular tabular material. A disproportionate amount of this tabular material was used for the now rare opposed platform strategies (table 6.11). In the cases of both J13 Phase II and J25 it is interesting that extra energy was still expended to acquire material considered most suitable for a subsidiary component of the reduction repertoire.

8) At Azraq 31 where the distribution of alternative sources and the particular sources likely to have been used is unclear, the significance of the presence of only tabular material in the Late PPNB and dominance of the Late Neolithic assemblage by tabular material, but with a significant component of lower quality chert wadi cobbles, is difficult to ascertain (table 6.1).

It is worth considering the exotic materials separately for a moment. The colouration and lustre of the exotic red material could well suggest that it is heat treated. The oxidization of iron in flints and cherts on heat treatment can bring out the range of colours found in this material. Clearly, if this material was heat treated, it represents extra investment of effort to obtain material of desired quality. A significant question remains as to whether it is heat treated Jilat material or whether heat treated or not it was imported. A certain amount of Jilat material was certainly burnt; the effects of this are evident in blackening and spalling. This material, clearly from various Jilat sources, shows some colour alteration. This alteration takes the form of a change from the usual grey or grey brown of the tabular and wadi material or light purple of the wadi material to a light blue, blue-grey or blue-white colour. Whilst this burnt material may have been subject to higher temperatures than considered ideal for heat treatment, it does not show any indication of the colouration of the exotic red material. In addition on those examples of exotic red material with cortex preserved, the original raw material included cobble and tabular forms which have a rather different character from those encountered in Jilat. The tabular material has a rose pink colour to its cortex and the cortical surfaces have a number of irregularities not noted on Jilat tabular material. Some rounded cobbles of exotic red material sometimes have unabraded white cortex indicating they are highly unlikely to be wadi rolled material; no cobbles in Jilat have such cortical surfaces. It seems very likely then, even in the absence of heat treatment experiments on the Jilat raw material, that this exotic red material was imported from outside the Jilat drainage system. Limited inspection of neighbouring drainages did not indicate the presence of material in any way similar to this exotic red material. If imported, this material, almost certainly, was carried from a distance of over 10 km. As has been argued above, it is likely, in an environment where procurement was embedded in site location, that import of material over some distance involved some extra cost. That the 16.5% cores of this material in the Early PPNB does represent a desire to obtain this specific material at extra cost is indicated by the nature of its use. If this material was the result of only generalised procurement embedded in other activities, without any specific purpose in mind, we would expect to see this material occurring in proportionate frequencies in different debitage and tool categories. This is not the case. In the Early PPNB this material was clearly favoured for the production of Khiam and Helwan points, Hagdud truncations and slender bladelet piercers (fig. 8.2:2 and 3). It might be tempting to suggest that the small size of exotic red cores relates to intensive use of 'expensive' raw material. However, there are many other small cores of standard Jilat materials in the Early PPNB (section 6.5.2). Bladelet production was important in this phase (sections 6.7.1-6.7.2). Khiam and many Helwan points, Hagduds and the piercers are made on bladelets. The small size of cores, whether of local or exotic material, almost certainly relates to the nature of blank requirements (section 6.5.2). During the Early PPNB it is clear this raw material was obtained in quantity (possibly with an investment involving heat treatment) with the specific intention of producing very distinctive types. This represents directed procurement with related costs. The acquisition of this material should be seen as a very significant extension of the phenomenon of raw material selection related to different production strategies on J7 Phase I.

The occurrence of exotic red material on sites post-dating Jilat 7 Phase I is sporadic and cannot be placed into any specific inter-related procurement and production strategies. Whilst there are cores of the exotic translucent yellow material on J26 and J25, it occurs as blade-bladelet debitage on J7 Phase I and amongst tools and debitage on J13 Phases I and II. Whilst there was no evidence of this material in Jilat, its surface characteristics in raw form suggest that its geological setting would be similar to that of the Jilat material and it may not have derived from a great distance. There are relatively few flakes of this material compared to blade-bladelets, which may suggest that core preforming took place off-site, possibly close to source. Given that procurement of this material was sporadic and production was not differentiated from that of other materials, nor aimed at specific products, there is little evidence that procurement and import were other than relatively opportunistic and quite possibly embedded in other activities. The same case can be made for exotic red material in the 7th and early 6th M.b.c.

Section 6.6.4 Summary of raw material procurement and use.

Throughout the Jilat sequence there is evidence that raw material was used differentially for different reduction strategies. To match this selectivity in use some degree of selectivity in procurement is evident in most occupations whether this involved extra effort or not. This data suggests that in certain settings the variable availability of different raw material types, cobble as opposed to tabular sources for example, might influence frequency of use of particular reduction strategies, but that in Jilat they did not. It is clear that each raw material type could be used for each broad reduction strategy whether preferred or not. It is also clear that degree of interest in obtaining preferred material could vary considerably in the same production settings. Thus consistent efforts were made to obtain tabular material for opposed platform particularly naviform strategies on J26, probably incurring extra effort. On broadly coeval J7 Phase II and also during Phase III a similar emphasis exists on opposed platform and particularly naviform production and tabular material is available at no extra costs, but the same degree of selectivity is not indicated as that practised on J7. In this setting the evidence is that requirements of reduction strategies influenced procurement practice to a considerable but highly variable extent. The evidence of J13 Phase II and J25 is that, where even a minor interest existed in opposed platform reduction, extra efforts might be expended to obtain some preferred material. This strongly suggests that the changes from the dominance of opposed to single platform and change of orientation strategies cannot be related merely to the dominance of wadi material in immediately adjacent settings since extra efforts were made. The evidence of Jilat is that changes in procurement are intimately related to changes in overall production requirements and that reduction strategies are not conditioned by procurement factors.

Section 6.6.5. Obsidian reduction strategies; temporal variation.

J7 and J13 have produced obsidian. A single obsidian bladelet fragment was recovered from Late Neolithic contexts at Azraq 31 (fig. 4.5:8). All of the pieces from Late Neolithic Azraq 31 (fig. 4.5:8) and J13 Phases I and II (fig. 4.5:1, 2, and 6) are of the same light grey-green colour which is characteristic of peralkaline obsidian. In the Near East, peralkaline obsidian has so far only been documented at Nemrut Dag, near Lake Van (Renfrew, Dixon and Cann 1966, 39). The obsidian from Late Neolithic J13 and Azraq 31 is therefore all from Lake Van, based on this criterion.

In contrast, the pieces from J7 Phases I and II (fig. 4.5:3, 4, 5, and 7), that is Early and Middle PPNB are mostly a light smokey-grey and the distinctive grey-green obsidian found on the later sites is absent. There is a contrast in the technology (and possibly the setting) of production as well. The obsidian from J7 is produced using opposed platform reduction strategies (fig. 4.5:3 and 5) similar to those used in the flint chipped stone assemblages there. Thus, these strategies include classic preparation and rejuvenation elements, including crested elements or with pieces indicative of cresting (fig. 4.5:3) and overshots (fig. 4.5:5) (the last possibly indicative of knapping errors). The Late Neolithic obsidian is all bladelet material, produced from very regular, single-platform pyramidal and conical cores (fig. 4.5:1, 2, 6, and 8). This distinction may suggest that avenues of distribution and organization of production were different for groups in this area between the 7th and 6th M.b.c.

Section 6.7 Debitage

Section 6.7.1 Frequency of occurrence of different debitage types.

In assemblages where debitage provides the main blanks for tools the characterization of that debitage clearly informs us about the ends of strategy and technique. Potentially, variation in such debitage may inform on the presence of different aims given the same techniques and strategies or different strategies and techniques if the aims can be demonstrated to be similar. Aims can best be gauged from retouched tools, strategies from cores and techniques from platform and bulbar features. Blade-bladelet blanks dominate all the tool assemblages and blade-bladelet cores dominate most core assemblages (table 6.8). Characterization of lamellar debitage was considered, therefore, to be potentially more rewarding in providing information on variations in the aims and the relationships between strategy and those aims. Clearly the proportions of different debitage classes will also inform on aims and strategies as well as the possible significance of contextual factors.

In the Early PPNB on J7 (fig. 6.68) as in mixed deposits in the upper levels of J7A (fig. 6.69)(section 4.4.1) - but which probably relate to Phase II activity - and in Phase II deposits in J7B (fig. 6.70) the proportions of blade-bladelets and flakes (that is debitage and blanks combined) in the assemblage are very similar. Blades and bladelets form 60-66% of the total blade-bladelets and flakes from these assemblages and flakes 34-40%.

In J7 Phase III (fig. 6.71) flakes are a somewhat higher proportion of the blade-bladelet and flake debitage than in the earlier assemblages on J7, that is 44%. This may relate to the amount of reduction of tabular material using specific tabular edge and particular naviform reduction strategies and thus considerable numbers of CxF1 and CxF2 flakes (sections 6.5.1 and 6.7.3).

At Middle PPNB J26 flakes (their high proportions ascribed to an even greater importance of tabular reduction - cores indicate a very low occurrence of strategies aimed at flake production, section 6.5.3) actually slightly outnumber blades and bladelets (fig. 6.72).

At Late PPNB (fig. 6.73) and Late Neolithic (fig. 6.74) Azraq 31 very similar proportions of flakes and blade-bladelets occur in both assemblages (part of the very close similarity between these two assemblages). Blades and bladelets at 62-66% form similar proportions of the assemblages as on J7 Phases I-II.

In both phases of occupation on J13 (figs. 6.75 and 6.76) blades and bladelets occur in almost identical proportions c. 57% and remain as important, as several and in fact more important than some, of the Jilat PPNB assemblages.

As the analysis of the technology at J25 indicated this was one of the few Azraq Project Neolithic assemblages that could be typified as a flake assemblage. Flakes form almost 75% of the flake and blade-bladelet debitage (fig. 6.77) and flake cores are actually very important (section 6.5.3).

The evidence of these statistics is clear. As the analysis of the blank types of the cores suggested (section 6.5.3), all assemblages PPNB and Late Neolithic, except J25, can be described confidently as blade-bladelet assemblages in terms of an intention to produce relatively high proportions of blade-bladelet debitage. The variation in the proportions of flakes in the flake, blade, bladelet debitage can probably be ascribed to the variations in the strategies employed to produce that lamellar debitage. That the production of lamellar debitage was paramount is also indicated by the tool blanks, dominated as they are by blade-bladelet blanks (sections 8.2-8.3), including J25.

Section 6.7.2 Blade-bladelet dimensions.

The more detailed characterization of the dimensions of blades and bladelets produced some interesting indications of variation. Throughout the assemblages there were no clear indications of consistent metric criteria that would allow the distinction of blades from bladelets on a significant basis. The arbitrary nature of the 40 mm. length, 12 mm. width criteria was underlined, but other thresholds would have been equally as arbitrary (figs. 6.78-6.95).

Only in the case of the Early Phase from J7 does a blade bladelet distinction do more than arbitrarily distinguish the smallest lamellar debitage. Here there was very little elongated debitage more than 50 mm. long (fig. 6.78) and 15 mm. wide (fig. 6.79) so that one could legitimately characterise this as a bladelet assemblage, adopting these measurements as a threshold. Using blade-bladelets from context J7 Ab25a to represent this phase the following observations describe the lamellar debitage (fig. 6.78). The bulk is between 15 and 35 mm. long, smaller proportions are between 35-45 mm. and only sporadic numbers of blades are more than 50 mm. long, none are over 75 mm. in length (fig. 6.78). The bulk of this debitage is between 3-12 mm. wide and few pieces are over 15 mm. in width (fig. 6.79).

The blade-bladelet debitage from J7 Phase II, represented by that from context J7 B33a (figs. 6.80 and 6.81), provides a notable contrast with that from the Early PPNB deposit. The greatest proportion of lamellar debitage is also small, between 15 and 35 mm. in length (fig. 6.80) and 3-15 mm. in width (fig. 6.81), but there is a significant proportion between 45 and 65 mm. long and 15-21 mm. wide. Such pieces are relatively unimportant in the Early PPNB sample. There are very few pieces over 75 mm. long and a few blades 24-30 mm. wide.

The lamellar debitage from J7 Phase III contrasts clearly with that from J7 Phase II. There are more larger blades in the J7 Phase III sample excavated from context J7 B11a (figs. 6.82 and 6.83). Thus the greatest proportion of lamellar debitage is small, as with the earlier phase samples on J7, but more of this smallest bladelet debitage is larger than equivalent material from J7 Phases I and II. So the greatest proportion of the J7 Phase III sample is between 20 and 40 mm. long (fig. 6.82) and 6-21 mm. wide (fig. 6.83). However, a sizeable proportion is 50-60 mm. long and significant numbers of blades occur in the 65-over 100 mm. range (fig. 6.82). More of these blades are wider than those in J7 Phase II. Hence significantly higher proportions of blades from this sample are between 24 and 27 mm. wide compared to the J7 Phase II sample and blades between 33 and 42 mm. wide also are present (fig. 6.83).

Unfortunately only a small sample of J32 blade-bladelets was measured. Tentatively these suggest that the bulk of lamellar debitage is between 15 and 40 mm. long, with the highest proportion 30-40 mm. long. Significant proportions are 45-60 mm. long and only small proportions are blades over 60 mm. in length (fig. 6.84). Most of this debitage is 6-

18 mm. wide, the highest proportions of which are 12-15 mm. wide. A low but significant component was 18-24 mm. wide and only sporadic examples attain a width of more than 24 mm. (fig. 6.85). This blade-bladelet debitage best compares with that from J7 Phase II, although there is a higher component of wider blades in this latter occupation on the basis of sample J7 B33a (fig. 6.81).

At J26 (J26 Cc17a) the bulk of blade-bladelet debitage is 20-40 mm. long (fig. 6.86); there is not as much of the shortest debitage encountered in the samples from J7 Phase I and II or J32. A lower proportion of blade-bladelets between 40 and 50 mm. long is also important (fig. 6.86). In fact, overall elongated debitage between 30 and 50 mm. long is important relative to many other samples. There is a distinct fall off in proportions of blades over 50 mm. in length. The bulk of these blade-bladelets are 6-15 mm. wide with a small but important component 15-21 mm. wide and a distinct fall off in pieces wider than this (fig. 6.87). There would appear to be lower proportions of longer and wider blades in the J26 sample relative to J7 Phases II and III, or even J32 (figs. 6.80-6.85). This is also the case relative to J13 Phase I blade-bladelets.

Because of small sample size it was unfortunately necessary to treat the Azraq 31 Late PPNB and Late Neolithic samples together for comparison with those from Jilat. The bulk of the blade-bladelets were 15-35 mm. long, with significant proportions 40-45 mm. long (fig. 6.88). There were only a few longer pieces, although clearly some of these could attain relatively great length. This elongated debitage sample shows a peak of widths between 9 and 12 mm. representative of the dominant group of blade-bladelets 3-18 mm. wide with a distinct fall off in occurrences over 18 mm. (fig. 6.89).

J13 Phase I blade-bladelets peak in the 20-30 mm. length range, the bulk are between 5 and 40 mm. in length (fig. 6.90). There is thus a very significant component of rather short bladelets. There is also a significant part of the distribution of lengths in the 50-70 mm. range. Few blades are over 80 mm. in length (fig. 6.90). There is more longer debitage in J7 Phases I and II, but not J26. The bulk of this debitage is between 3 and 15 mm. wide, blades between 15 and 21 mm. are a significant component and there is a small component 21-26 mm. wide (fig. 6.91).

In the J13 Phase II sample the bulk of blade-bladelets are 15-40 mm. long with maximum numbers 15-25 mm. long (fig. 6.92). There are not as many short bladelets, but a greater proportion in the 15-25 mm. length range (fig. 6.92). Blades 45-65 mm long are a small but significant proportion of elongated debitage from J13 B7c. The bulk of this debitage is 3-12 mm. wide and a significant proportion is 12-21 mm. wide (fig. 6.93). There is a low frequency of occurrence of pieces over 21 mm. in width (fig. 6.93).

At J25 the sample from J25 Aa2b is small but suggests that the bulk of the lamellar debitage was 10-35 mm. long (fig. 6.94). Blades 40-75 mm. long form a distinctly high proportion of this debitage, however, with a notable proportion between 50 and 60 mm. in length. The bulk of these blade-bladelets are 3-18 mm. in width but blades with widths in the 21-33 mm. range are relatively important (fig. 6.95). This suggests a significant component of relatively long, wide lamellar debitage.

Comparison between the different Late Neolithic debitage assemblages is instructive. Comparison with Azraq 31 would probably be invalid because of low sample size there. However, there are few major distinctions between the J13 B77a.vii (figs. 6.90 and 6.91) and J13 B7c samples (figs. 6.92 and 6.93) in the lengths or widths of the blade-bladelets. At J25 there may be a slightly higher proportion of longer (fig. 6.94), but there certainly is a higher proportion of wider, blade-bladelets (fig. 6.95). It is suggested that many of the blades from J25 are linked more closely to the dominant flake component of the assemblage from that site than is the case at the other sites. There is not as high a proportion of larger blades as on J7 Phases II (figs. 6.80 and 6.81) and III (figs. 6.82 and 6.83) in these Late Neolithic assemblages, but larger blades are more important than on J26.

The thickness of this debitage is also informative. Most of the debitage samples discussed above have the same range of thicknesses. Thus most blade-bladelets are between 1 and 3 mm. in thickness. There is a rapid fall off in the proportions of samples thicker than 3 mm., with some blade-bladelets between 3 and 6 mm. in thickness and very few thicker than this. The samples that conform to this pattern are J7 Phase I (fig. 6.96) and II (fig. 6.97), J26 (fig. 6.98), and J13 Phase II (fig. 6.99). The J32 sample (fig. 6.100) departs slightly from this norm with a marginally higher proportion of blade-bladelets between 6 and 9 mm. thick. The samples that depart significantly from this pattern are all Late Neolithic and have a significant Late Neolithic component (Azraq 31). Thus at Azraq 31 there is a relatively high proportion of blade-bladelets 3-6 mm. thick (fig. 6.101). At J13 Phase I there is a very high proportion 3-6 mm. thick and also a small but significant proportion 9-12 mm. thick (fig. 6.102). A very similar pattern to this is evident in the J25 sample (fig. 6.103). It does seem then that a relatively high proportion of Late Neolithic blade-bladelet debitage is thicker than most PPNB debitage.

Some control on the representativeness of these blade-bladelet debitage samples may be provided by looking at variation in the proportions of the broad bladelet, blade and blade-bladelet categories from all contexts analyzed from each occupation. The thresholds, that distinguish these conditional classes, do not allow direct comparison of the frequency distributions and the wider samples which, to further complicate comparison, consist of much fragmented material. These thresholds are bladelets length

<41 mm., width <13 mm.; blades length >40 mm., width >12 mm.; Blade/bladelets length ?, width <12 mm.

The J7 occupation samples clearly support the contrasts noted between the frequency distributions of complete lamellar debitage from the individual context samples chosen from each of these phases. Thus in the Early PPNB sample bladelets are only slightly less frequent than blades (appendix 1). The frequency of lamellar debitage drops over 45 mm. in length, so some of the blades and, no doubt, many of the blade/bladelets, belong to the dominant relatively short component of this J7 Phase I elongated debitage. However, the proportions of blades do indicate that, as we might expect, the longer elongated debitage is less well represented because of fragmentation.

The contrasts between J7 Phases II and III and between them and the Early PPNB are still marked, however, in the broader, but less precisely documented samples. In J7 Phase II blades are 1.5 times as common as bladelets and in J7 Phase III blades are twice as important as bladelets (appendix 1). These broader samples indicate a very similar situation to those suggested by the frequency distributions of the individual context samples. The greater importance of blades in the J7 Phase III sample than J7 Phase II and the probable representative character of the frequency distributions may be taken as confirmation of the importance of larger lamellar debitage in J7 Phase III compared to Phase II.

In the contexts from J26 treated as a whole, the ratio of blades to bladelets is even higher than on J7 Phase III, over 2.5:1 (appendix 1). Taken with the somewhat lower proportions of blade/bladelets on J26 it suggests the unrepresentative character of the frequency distributions. The frequency distributions did suggest the relative importance of blades in the 40-55 mm. length range relative to other occupations, but even these appear to be unrepresentative. The fragmentation of longer blade debitage is probably responsible for this. In broad terms we must assume that the lamellar debitage from J26 was more comparable to that from J7 Phases II or III than the frequency distributions indicate. It is clear that a higher proportion of the lamellar debitage from J26 was relatively wide even compared to that from J7 Phase III, more of which was wider than that from J7 Phase II.

The importance of longer lamellar debitage at Azraq 31, as expressed by blade:bladelet ratios, is clear, particularly in the Late PPNB where it is 4:1; it is 3:1 in the Late Neolithic (appendix 1). These ratios provide a clear contrast with Jilat sites of 7th and 6th M.b.c. and are part of the reason for treating the small Azraq context samples of the different periods together in the frequency distributions. The importance of relatively narrow debitage is clear from the high proportion of blade/bladelets (appendix 1). These observations can well be reconciled with the small sample frequency distributions of lengths and widths from two Azraq 31 contexts. There is, however, a strong possibility that some of the longer lamellar debitage may be under-represented in the frequency distributions because of fragmentation.

The similarity in the proportions of blades and bladelets from J13 Phases I and II (appendix 1) may well suggest that the comparability of the frequency distributions of length, width and thickness of lamellar debitage from J13 B77a and B7c is a valid phenomenon. However, the low proportion of debitage over 40 mm. in length in the frequency distributions of complete lamellar debitage argues considerable caution. Almost certainly a higher proportion of longer debitage has suffered fragmentation, essentially invalidating inter-site and inter-occupation comparisons based on the frequency distributions.

The relative importance of debitage over 40 mm. in length in the frequency distributions, the relative importance of bladelets in the broader sample and the low proportion of blade/bladelets (appendix 1) suggest that the frequency distributions of the small sample examined from J25 may be representative.

Whatever the precise nature of the larger lamellar debitage and it is certainly quite varied on J7, it occurs as a relatively constant proportion, 29-35% of elongated debitage throughout the 7th and 6th M.b.c. assemblages here analyzed. The exception is J26 where blades reach 40% of the lamellar debitage an indication of the importance at least of wider long lamellar debitage in this occupation and of the particular unrepresentative nature of the sample providing the frequency distributions.

Section 6.7.3 Flakes.

The study of reduction strategy preserved by cores, particularly preforms, and the nature of blanks, indicated that a substantial proportion of flakes, and in particular cortical flakes, resulted from preparation and re-preparation of cores. In particular, when naviform strategies were in operation, they resulted from the preparation of multiple crests and consequent decortication of substantial areas of the core.

In particular the preservation of preforms of tabular material (fig. 6.6) and well preserved cores (figs. 6.7; 6.8) indicated specific strategies of preparation of this material for naviform and tabular reduction strategies. These strategies clearly generated considerable quantities of very specific types of cortical flakes. After these characteristic cortical flakes were identified on Azraq Project Neolithic sites, publications of debitage from Late PPNB Basta (Nissen *et al* 1987) provided a more detailed schema and nomenclature for these flakes which it was decided to adopt. This includes the use of the CxF1 and CxF2 designations.

Preparation of crests, whether for naviform or tabular reduction, always seems to have begun with the removal of multiple flakes along the edge(s), across the thickness of the plaquette (figs. 6.6-6.8). The Cortical Flakes 1(CxF1) that resulted have a very distinctive character. They have cortical platforms and cortical obverse distal ends which form two parallel planes (parts of the surfaces of the core) and the two edges of the flakes diverge from the platform to that distal end. Many crested blades, preforms and cores further reduced (figs. 6.6-6.8), indicate that crest preparation often consisted solely in the removal of CxF1's. On the other hand, particularly on naviform cores, there is evidence of a further stage in crest production. This involved the removal of a series of flakes from the face created by the removal of CxF1's along the edge of the plaquette at an angle somewhat under 90° to the surface of that face. As a result these flakes, CxF2, had non-cortical, that is plain, dihedral or facetted platforms, less regular and not divergent edges, and relatively flat obverse surfaces with relatively extensive cortex (not just confined to the distal end of the flake) representing the surface of the tablet.

In those 7th M.b.c. assemblages where flakes are particularly important, that is J26 and J7 Phase III, cortical flakes are a high proportion of the flake assemblage as a whole (appendix 1) and the cortical flakes are dominated by CxF1's and to a lesser extent CxF2's. Very significant proportions of these assemblages derive from preparation of naviform *sensu lato* and tabular cores.

On 8th M.b.c. J7, where naviform and tabular production strategies are less important than in the 7th M.b.c., non-cortical flakes are more important than cortical (appendix 1) and CxF1's and CxF2's are uncommon.

At J32 where tabular material is much less important than on other 7th M.b.c. sites in Jilat, CxF1's and CxF2's are still relatively important. The indications from J26, J7 III and J32 are that tabular raw material preparation for naviform *sensu lato* and tabular reduction strategies generated relatively voluminous debitage.

At Azraq 31 in both Late Neolithic and PPNB occupations naviform and tabular strategies are important and CxF1's and CxF2's are important components of the more important cortical flakes (appendix 1).

In the Late Neolithic the change in strategies results in a different pattern. Tabular strategies are important on both J13 Phase I and II occupations and naviform strategies remain important in J13 Phase I. However, non-cortical flakes are less important in Phase I than II (appendix 1), although in Phase I CxF1's retain some importance in the assemblage. A considerable proportion of the more important cortical flakes on J13 Phase II and J25 are flakes that result from the reduction of wadi cobbles by single and change of orientation strategies which removed extensive areas of cortex, but not as part of specialized preparation strategies, with multiple and extensive cresting as, for example, on naviform cores *sensu lato* and tabular strategy cores.

Section 6.8 Technique.

Section 6.8.1 The identification and interpretation of technique-related variation.

A definition of technique has been offered already at the beginning of this section on technology. It is those factors that influence the nature of the impact that removes a piece of chipped stone from its parent body. Key factors, observed by experimenters, are relative hardness or softness of impactor, direct or indirect percussion or pressure, shape of contact area of impactor (Knutsson 1988, 39), force and velocity with which the blow is delivered, angle at which the blow is delivered, the manner in which the core is held steady, platform features and smoothness (Bordes 1947, Bonnichsen 1977, Ohnuma and Bergman 1982, Knutsson 1988). Other key factors also observed are the degree of proximity of impactor to platform edge and the degree of definition and size of the area of impact on the platform itself (Bordes 1947, Bonnichsen 1977, Ohnuma and Bergman 1982, Knutsson 1988). It has been effectively demonstrated by Ohnuma and Bergman (1982) that it is the hardness of the hammer relative to the hardness of the core material, rather than precisely which material, wood, stone, antler which determines, in combination with other factors, the nature of many features on platforms and bulbs of removals. Thus stone hammers, softer than the core material, will produce features on platforms and bulbs similar to **other soft** hammer materials. Particularly relevant to the current study has been experimental replication of naviform cores by Quintero, where using a stone hammer softer than the material reduced, she and a co-worker produced features normally associated with soft hammer materials (personal observation, Quintero pers comm.)(see below). It has been indicated that it is difficult to readily separate out which impact factors produce specific features on platforms and bulbs observed on modern and prehistoric debitage. Thus relatively early the association between lips and soft hammer percussion/pressure was made (Bordes 1947, Tixier *et al* 1980, 91), but Bonnichsen (1977) has demonstrated that this may have much to do with the angle at which the impact occurs and suggested that the observed association related to preferred angles for soft hammer flaking. Bordes (1947) main observations were that hard hammers produced large platforms with clear points and cones of percussion, pronounced bulbs and circular fissures on the platform around the point of impact (I have termed these ring fractures). Bordes maintained soft hammer products were characterized by narrow, often punctiform platforms, a lip between platform surface and inverse surface, no points or cones of percussion and diffuse bulbs. Experimenters have indicated that the degree of diffuseness of the bulb probably related to the amount of surface contacted by the impactor. They have also observed the propensity for hammerstones of certain materials to soften through use, potentially a hammer, hard relative to the core material could become relatively soft. It also became generally appreciated amongst experimenters that size of platform would be strongly related to the position of the point of impact relative to platform edge (Ohnuma and Bergman 1982). In their experiments Ohnuma and Bergman (1982) observed that the presence or absence of cortex on the platform meant the production of different features under the same impact regime, presumably the presence of platform facetting would have an analogous effect.

The potential complexity of the relationships between input factors and observed features on debitage (Knutsson 1988, 38) suggest a two stage procedure in the interpretation of variation in techniques between and within assemblages.
1) The identification of the nature of technique related differences between assemblages. On this basis it may well be possible to infer the presence of significantly different techniques for the production of types of debitage on an inter- or intra-assemblage basis without necessarily being able to infer the actual techniques or specific differences in technique involved.
2)The inference, in an imprecise manner, of the range of some of the techniques probably involved in the production of the debitage concerned.

The inference of technique from platform and bulb features has been indicated to be a difficult process. Certain observations, by those who experiment with the flaking of stone, provide useful criteria for distinguishing pressure/indirect/soft impact related techniques from those involved in harder hammer production. Many of these criteria should not be viewed as absolute, their occurrence will vary with the exact combination of factors involved. There seems to be a gradual change in attributes over the hard-soft scale related to the precise combination of input factors. Further, whilst presence of these criteria may well be indicative, absence does not indicate absence of the technique factors involved.

Since Bordes seminal work (see above) further experiments have refined our definition of technique-related criteria. Repeated experiments suggest no precise individual correlations between specific stigmata on platform and bulb and particular techniques.
1) Siret fractures (Tixier *et al* 1980, 103) are certainly associated with relatively hard hammers, but vary in frequency depending on proportions of debitage (whether blades or flakes are produced, for example). They may also be associated with use of a rigid support/anvil and are closely related to the brittleness of the material flaked (Knutsson 1988, 39). They are thus particularly common in quartz assemblages.

2) Ring fractures (Knutsson's incipient cone cracks) recognized by Bordes as circular fissures on the platform and associated by him with hard hammer impact, are still most frequently correlated with harder hammers especially when they are concentric to crushing indicating the precise point of impact (Knutsson 1988, 42 and fig. 10).

The experiments of Ohnuma and Bergman (1982) suggested that combinations of features could best be used to separate relatively hard from relatively soft impactors. They observed that all pieces they produced with
3) both lips and diffuse bulbs were softer hammer products.
4) No lips and pronounced bulbs were harder hammer products.

5) Clear point and cone of percussion were hard hammer products. These were identified by the distinct, salient knob on the bottom of the platform adjacent to the inverse surface created by the apex of the cone of percussion at the point of impact. In addition they identified a group 6) without clear points or cones of percussion with diffuse bulbs which were highly correlated with softer hammer impact.

Knutsson suggests a high degree of correlation between eraillure flakes and harder hammer impactors (Knutsson 1988, 42) and indicates that platform crushing is closely related to harder hammer impact, although it should be seen as occurring with relatively hard soft hammers (Knutsson 1988, fig. 10) probably in situations where impact occurs at a relatively high velocity.

The problematic and imprecise degree of correlation between platform and bulb attributes and technique related factors mean that, in order to infer the relative importance of dominant components of the pressure/indirect/softer-harder impactor in particular groups of debitage, we must use the combinations of criteria outlined above with a degree of circumspection. We can use some evidence from the assemblages themselves, however, to control the consistency of observation and validity of the correlation of combined attributes and technique related factors.

In the Azraq Project Neolithic assemblages attributes of platforms and bulbs of blade-bladelet debitage and blanks were recorded. Attributes of flakes were not recorded because many flake platforms have cortex, which as observed by Ohnuma and Bergman (1982), renders highly problematic some of the correlations between attributes and technique related factors. As Knutsson (1988, 42) has pointed out, technique related input factors are unlikely to vary independently of strategy. Within the Jilat and Azraq assemblages a considerable proportion of flakes were clearly produced as part of preparation processes and as tool blanks indicate that blades were the dominant desired product it was clearly essential to study technique-related attributes of blades and flakes separately. Given a need for priorities since blades were so clearly the desired end product, and all the assemblages, except that from J25, could be characterized as blade assemblages, it seemed appropriate to concentrate on potential variation in technique related to blade production rather than core preparation. Further preliminary inspection of flakes suggested less variation in technique-related attributes between assemblages on flakes than blades; most criteria pointed to a dominance of hard hammer flake production i.e. core preparation. This pattern has been observed in several other Levantine Neolithic and also Epipalaeolithic assemblages (Campbell and Baird 1991; Henry 1992, 133-134; Nishiaki 1992) and may well be a widespread phenomenon. It seemed potentially more rewarding to concentrate on possible variation in technique related to blade production. 1488 blade platforms and bulbs from contexts representative of each occupation provide the sample upon which the following analysis is based.

Section 6.8.2 Analysis of attribute variation relating to technique.

The platform and bulb characteristics detailed above were recorded. The basic platform types and their definitions are well understood and detailed in Tixier (*et al* 1980). In addition bulb features recorded include whether the bulb was prominent, diffuse or undistinctive. Degree of prominence and to a lesser extent diffuseness are relative phenomena - no absolute measurement system was used or indeed could be used with ease. The guiding criterion for diffuse bulbs could be employed on a regular and systematic basis, however; this is because it involved the absence of any salient area on the inverse at the proximal end of debitage or blank. The presence of eraillures and large eraillures was recorded, as was the presence of median or radial cracks on the bulb (Knutsson 1988). Conic platforms were those where impact left an upstanding cone of percussion when the rest of the platform collapsed. One presumes these are most likely harder hammer related phenomena.

Table 6.12. Numbers and proportions of different types of platform features in each occupation.

Table 6.12a

	J7 I	J7 II	J7 III	J26	J32	J13 I	J13 II	J25	Az31 I	Az31 II
Platform type										
Plain	88	103	77	87	9	79	107	28	30	24
Winged	9	11	8	12	6	17	2	2	3	2
Dihedral	17	19	15	20	2	6	14	4	2	1
Punctiform	13	14	12	19	3	11	7	1	9	7
Filiform	26	26	21	50	10	14	24	0	16	12
Platform facet	8	20	16	20	8	16	5	3	1	1
Removal surface facet	36	60	34	37	8	27	33	1	22	15
Cortical	26	18	17	28	4	22	17	12	8	6
Crushed	27	40	25	38	12	27	39	10	0	4
Lip	55	63	40	72	26	40	49	12	39	24
Ring crack	0	10	4	11	0	10	4	3	0	0
Bulb features										
Diffuse	69	81	48	87	23	54	45	13	43	27
Prominent	37	34	26	38	7	18	23	16	1	7
Clear cone	25	17	11	31	4	20	9	7	1	2
Conical	0	1	4	2	0	3	0	1	1	3
Siret	0	2	0	0	1	5	0	0	0	1
Large Eraillure	5	19	18	27	2	18	18	8	3	6
Total Platforms	180	247	164	255	61	168	212	60	63	56

Table 6.12b

Platform type	J7 I	J7 II	J7 III	J26	J32	J13 I	J13 II	J25	Az31 I	Az31 II
	%	%	%	%	%	%	%	%	%	%
Plain	48.89	41.70	46.95	34.12	14.75	47.02	50.47	46.67	47.62	42.86
Winged	5.00	4.45	4.88	4.71	9.84	10.12	0.94	3.33	4.76	3.57
Dihedral	9.44	7.69	9.15	7.84	3.28	3.57	6.60	6.67	3.17	1.78
Punctiform	7.22	5.67	7.32	7.45	4.92	6.55	3.30	1.67	14.29	12.5
Filiform	14.44	10.53	12.80	19.61	16.39	8.33	11.32	0.00	25.39	21.43
Platform facet	4.44	8.09	9.76	7.84	13.11	9.52	2.36	5.00	1.58	1.78
Removal surface facet	20.00	24.29	20.73	14.51	13.11	16.07	15.56	1.67	34.92	26.78
Cortical	14.44	7.28	10.36	10.98	6.55	13.09	8.02	20.00	12.69	10.71
Crushed	15.00	16.19	15.24	14.90	19.67	16.07	18.40	16.66	0.00	7.14
Lip	30.55	25.51	24.39	28.24	42.62	23.81	23.11	20.00	61.90	42.86
Ring crack	0.00	4.05	2.44	4.31	0.00	5.95	1.88	5.00	0.00	0.00
Bulb features										
Diffuse	38.33	32.79	29.27	34.12	37.70	32.14	21.23	21.67	68.23	48.21
Prominent	20.55	13.76	15.85	14.90	11.47	10.71	10.85	26.67	1.58	12.50
Clear cone	13.89	6.88	6.71	12.16	6.56	11.90	4.25	11.67	1.58	3.57
Conical	0.00	0.40	2.44	0.78	0.00	1.78	0.00	1.67	1.58	5.36
Siret	0.00	0.81	0.00	0.00	1.64	2.97	0.00	0.00	0.00	1.78
Large Eraillure	2.78	7.69	10.97	10.59	3.28	10.71	8.49	13.33	4.76	10.71

Several clear distinctions can be made between different occupations on the basis of the data relating to platform and bulb features of blade-bladelet debitage (table 6.12).

1) The Azraq 31 occupations can be seen to be dramatically different from the Jilat sites, and in the Azraq 31 PPNB sample the differences are particularly marked (table 6.12). The Azraq 31 lamellar debitage from both occupations have very high proportions of filiform and punctiform platforms relative to the Jilat sites (table 6.12). The Azraq 31 occupations have the lowest proportions of platform facetting but very high proportions of blades have removal surface facetting (table 6.12). Crushed platforms are quite common on the Jilat occupations, but very low or absent from the Azraq 31 blade-bladelet sample (table 6.12). Lips occur on a very high proportion of Azraq 31 platforms. There are very high proportions of diffuse bulbs at Azraq 31 compared to Jilat sites, no ring cracks, very low proportions of clear points and cones of percussion and in the Azraq 31 Late PPNB sample a very low proportion of prominent bulbs (table 6.12).

2) The Jilat 25 sample is very distinct from Azraq and other Jilat occupations (table 6.12). There is a very low proportion of punctiform and filiform platforms, but cortical platforms occur in very high proportions, c. 20% (table 6.12). Platform facetting is quite low but removal surface facetting is very low indeed, only 1.67%. This J25 blade-bladelet sample has the lowest proportion of lips of any occupation (still 20%), the highest proportion of ring cracks, the lowest proportion of diffuse bulbs and the highest proportion of prominent bulbs (table 6.12).

3) Of the other Jilat sites J32 is somewhat distinct with a very low proportion of plain platforms (table 6.12), a relatively low proportion of dihedral platforms, a relatively high proportion of winged, filiform, and punctiform platforms, a very high proportion of lips (42%) and a relatively high proportion of platform facetting (table 6.12).

4) The lamellar debitage samples from most other Jilat occupations have a relatively similar range of platform and bulb characteristics; some can be distinguished by the importance of individual attributes. Plain platforms are dominant and make up 40-50% of all platforms from these Jilat occupations (table 6.12). J26 is slightly different, it has only 36% plain platforms. Dihedral platforms occur in a low but similar range, 6.6-9.5% with only a slightly lower proportion in J13 Phase I. Winged platforms form a low proportion of samples 3.3-4.5%, the exception, in addition to J32, is J13 Phase I which has a notably higher proportion of winged platforms, 10.12% (table 6.12). Punctiform platforms occur in the range 5-7.5%, J13 Phase II has slightly lower proportions. Filiform platforms occur in the range 8.5 -14.5% except on J26 where they are 19.5% (table 6.12). Platform facetting was not common to judge by these platforms (section 6.5.4), it is in the range 8-13%, it occurs in lower proportions on J7 Phase I and is very low on J13 Phase II where it occurs on only 2.3% of platforms (table 6.12). On the other

hand removal surface preparation is high on all the J7 phases where it is found on 20-25% of platforms; it is lower on other occupations 13-16% (table 6.12). Cortical platforms occur in the range 6.5-15%. Crushed platforms are a regular and standard occurrence and are 15-20% of all platforms. Both lips and diffuse bulbs occur within these Jilat occupations samples in restricted ranges in significant proportions, lips 20-30%, diffuse bulbs 29-39% (table 6.12). The exception in this regard is J13 Phase II which has lower proportions of diffuse bulbs c. 21%. Prominent bulbs occur in the range 10-16% except on J7 Phase I where they are 20% (table 6.12).

The preparation of the edge of the platform on the main removal surface was observed to take two forms: either 1) the fine flaking of the edge of the platform or 2) the grinding of the edge.

Table 6.13. Different types of preparation of platform edge on main removal surface.

Type Occupation	Flaked	Ground
J7 Phase I	29	7
J7 Phase II	45	15
J7 Phase III	20	14
J32	7	1
J26	16	21
J13 Phase I	18	9
J13 Phase II	14	19
Azraq 31 I	8	14
Azraq 31 II	8	7

Table 6.13 suggests a clear contrast between those occupations in which the edge of the platform was prepared predominantly by fine facetting, that is all J7 occupations, J32 and J13 Phase I, and those in which grinding and flaking were used more or less equally or grinding predominated slightly, that is J26, J13 Phase II and both Azraq 31 occupations.

That some of the distinctions, particularly the most striking (see 1 to 3 above), drawn between these occupations on the basis of platform and bulb features, probably relate to the employment by knappers of different technique combinations is further suggested by variations in the sizes of the platforms from each occupation context(s) sample. On the basis of platform width and height measurements the following distinctions can be made and observed in the frequency distributions of widths and heights for each occupation.

1) The Azraq 31 platform populations are dominated by a very high proportion of relatively narrow (figs. 6.104 and 6.105) and thin (figs. 6.106 and 6.107) platforms compared to the Jilat sites. All Jilat platform populations have a significant component of platforms over 4.5 mm. wide and over 1-1.5 mm. thick (figs. 6.108-6.123). There is a sharp fall off in numbers of platforms at Azraq 31 more than 4.5 mm. wide and 1-1.5 mm. thick (figs. 6.104-6.107). The high degree of distinctiveness of the Azraq 31 platforms is thus further emphasized.

2) J25 is distinct because it has a much higher proportion of larger platforms than other Jilat occupation samples. At J25 a high proportion of lamellar debitage platforms are in the 4.5-9 mm. width range (fig. 6.122) and in the 1-5 mm. thickness range (fig. 6.123).

3) On J13 the two samples do have distinctly contrasting distributions of platform widths and heights. The J13 Phase II population is not dissimilar to those of the PPNB in Jilat (see below point 4) (figs. 6.120 and 6.121). By contrast J13 Phase I has a high proportion of larger (wider and thicker) platforms in the 3-6 and 7.5-9 mm. width (fig. 6.118) and 1-3 mm height range (fig. 6.119), and is thus more akin to that from J25 (figs. 6.122 and 6.123).

There is some suggestion of a relationship between platform size and blade-bladelet character. It seems likely, therefore, that technique and blade-bladelet character may be related. The J13 Phase II blade-bladelet sample (section 6.7.2) is thinner than that from J13 Phase I and J25; it is more like PPNB samples. In this regard it is interesting that other technique factors in J13 Phase II relate more to those encountered in the PPNB. Clearly technique developments from PPNB into Late Neolithic were not straightforwardly unilinear.

4) Other Jilat platform groups are less distinctive one from the other. There are only slight differences in terms of platform widths between each of the three J7 phase samples (figs. 6.108-6.113) and the J26 sample (figs. 6.114 and 6.115). J7 Phase II (figs. 6.110 and 6.111) has more platforms in the 4.5-6 mm. range than in the 1.5-3 mm. range which is not the case at J26, J7 Phase I or III. J26 is notable in having its highest proportion of platforms less than 1.5 mm. wide (fig. 6.114), the highest proportion of most other population samples under consideration is in the 1.5-3 mm. range. Whilst not a dramatic difference J32 does not have as high a proportion of platforms in the 4.5-6 mm. width range (fig. 6.116) as other 7th M.b.c. Jilat samples. The J13 Phase II population is not dissimilar to these PPNB populations.

Frequencies of platform heights indicated that J26 (fig. 6.115), J7 Phase I (fig. 6.109) and J13 Phase II (fig. 6.121) were very similar with very high proportions of their platform populations consisting of very thin platforms. The other Jilat occupations, J32 (fig. 6.117), 7 II (fig. 6.111) and 7 III (fig. 6.113) also have high proportions of very thin platforms, particularly 32, but somewhat higher proportions of thicker platforms than 26, 7 I and 13 II.

Section 6.8.3 The documentation of pressure/indirect/soft impactor related techniques as opposed to those related to harder hammer use.

The stigmata produced by softer hammer, indirect percussion and pressure related technique combinations (henceforth referred to under the umbrella term softer hammer) have to be treated together and contrasted with harder hammer related techniques, at least in terms of debitage produced (see above).

Whether the data recorded from the Jilat material produced attributes or attribute groups that were discrete and did not occur on the same pieces, must first be assessed before such attributes can be used to interpret the presence or importance of contrasting softer or harder hammer related technique combinations.

Lips have been consistently associated with softer hammer techniques and clear points and cones of percussion with harder hammer techniques. If these stigmata accurately reflect these technique differences in a consistently observable fashion they should not occur on the same pieces of debitage. Of the 1488 platforms studied, of which 420 had lips and 127 clear points and cones of percussion, siret fractures or ring cracks, there are 8 examples of concurrence. It is possible that these are the results of misascription of phenomena observed. If a genuine concurrence they may indicate very specific technique factors; that this might be the case is suggested by the fact that four of the examples come from the relatively small J7 A34a blank sample. Even if this involved the misidentification of the phenomena observed, it seems likely that those phenomena represent a very specific set of features probably technique related. Whilst these 8 cases of concurrence suggest that lips or clear points cannot be used to indicate precisely specific instances of harder or softer hammer techniques, they are discrete enough groups to give, by their contrasting importance, broad indications of use and importance of softer and harder hammer techniques.

Other features that have been suggested as respectively associated with harder hammer and softer hammer techniques are prominent and diffuse bulbs. In this sample 226 diffuse bulbs have lips and only 17 have clear points and cones of percussion. Use of diffuse bulbs as a soft hammer indicator will, this suggests, give a less precise picture of softer hammer use than lips but still a broadly accurate one. Of prominent bulbs 54 had clear points and cones of percussion, but fully 23 had lips. This indicates that there may well be some association between prominent bulbs and harder hammer techniques, however, use of prominent bulbs by themselves as an indicator will not produce a reliable index of harder hammer use. This may be because of the relatively subjective nature of the identification of prominence in bulbs.

Punctiform and filiform platforms have been associated by experimenters (Tixier *et al* 1980, Calley 1986a) with softer hammer techniques. In these samples 133 filiform and 33 punctiform platforms have lips. Only 1 punctiform and 1 filiform platform had possible harder hammer stigmata, that is both cases had clear points and cones of percussion and the filiform platform also had a ring crack. This strongly suggests that both these platform types would be good softer hammer indicators.

These data suggest, that by looking at the general occurrence of lips, clear points and cones of percussion, punctiform and filiform platforms, Siret fractures and ring cracks and diffuse bulbs, some indication of the presence and potential relative importance of hard and softer hammer techniques may be reached.

As has already been indicated, lips occur at a relatively regular rate in almost all the Jilat occupation samples, that is on 20-30% of platforms. This suggests that softer hammer techniques almost certainly had a significant role in these Jilat assemblages and were probably used with approximately the same degree of frequency. J32 and the Azraq 31 occupations stand out from the others in Jilat with particularly high proportions of lips (table 6.12) indicating that softer hammer techniques were probably very important in the reduction strategies employed during these occupations. Clear points and cones of percussion occur in the range 1.5-13% of platforms from all these occupations suggesting that in all assemblages harder hammer techniques were also used, although probably not as extensively as softer hammer techniques (table 6.12). Azraq 31 PPNB with c. 1.5%, Azraq 31 Late Neolithic with c. 3.5% and J13 Phase II samples with 4.25% clear cones and points of percussion thus have a particularly low index of harder hammer uses. J7 Phases II and III and J32 have slightly higher proportions of clear cones and points of percussion on c. 6% of platforms, harder hammer use may have been somewhat more common in these industries. It was almost certainly more significant on J7 Phase I, J26, J13 Phase I and J25 where clear points and cones are in the range 11-13%. Ring cracks and Siret fractures occur only in very low proportions, but in most assemblages except J7 Phase I and Azraq 31 PPNB, a further indication that harder hammer techniques were present in addition to softer hammer techniques for blade-bladelet production in most assemblages. Ring cracks were most important, c. 4-6% in the samples from J7 Phase II, J26, J13 Phase I and J25 (table 6.12); three of these four assemblages are those with the relatively high proportions of clear cones and points of percussion, that is J26, J13 Phase I and J25. This fact may lend credence to the inference that this may be an indicator of the greater role for harder hammer technique(s) in blade production in these industries.

Diffuse bulbs, probably a relatively reliable softer hammer indicator, also occur in fairly standard proportions in most Jilat assemblages, that is 29-39% (table 6.12). In the Azraq occupations they are exceptionally important, 48-68%. On J25 and the later phase on J13 they are c. 21% of all bulbs (table 6.12). This information may be seen as a further indicator of the greater importance of softer hammer techniques at Azraq 31 than in the Jilat samples, the significant but relatively constant role of softer hammer production in most Jilat sites and confirms the lesser importance of softer hammer techniques at J25.

As a further indication of the relative importance of softer and harder hammer techniques in each occupation sample it was felt that a comparison of the ratio of the clearest softer hammer indicators with the clearest harder hammer indicators would serve. Bearing in mind the injunction of Ohnuma and Bergman (1982) that the discriminatory criteria give most reliable results when used in conjunction, the softer hammer indicators chosen were diffuse bulbs in conjunction with lips and the harder hammer criteria were prominent bulbs in conjunction with clear points and cones of percussion.

Table 6.14. Ratios of diffuse bulbs/lips:prominent bulbs/clear cones.

	Softer hammer	:	Harder hammer
J7 Phase I	2.5		1
J7 Phase II	4.2		1
J7 Phase III	4.7		1
J32	5.0		1
J26	2.7		1
J13 Phase I	3.6		1
J13 Phase II	11.0		1
J25	0.8		1
Az31 PPNB	29.0		0
Az31 Phase II	8.0		1

Figures in table 6.14 confirm the situation suggested by the individual indices. Softer hammer techniques are particularly important on the two Azraq 31 occupations and on J13 Phase II. Harder hammer techniques are probably relatively important on J25.

Softer hammer techniques are moderately important on the other Jilat occupations. There are some indications that on J26, J7 Early PPNB and possibly J13 Phase I harder hammer techniques may have had a slightly greater role than in the other Jilat assemblages, bar of course J25.

That variations in platform size are at least partly related to relative softness and hardness of hammer has already been suggested. Both Azraq 31 occupations stand out with their high proportions of particularly small platforms and J25 with the highest proportions of relatively large platforms (section 6.8.2). These distinctions correlate closely with the particular importance of softer hammer at Azraq 31 and harder hammer at J25. The general similarities between the other Jilat samples, except for J13 I, may well reflect the similar role and relative importance of softer hammer techniques. The greater importance of larger platforms at J13 Phase I may be partly explained by the somewhat more important role of harder hammer use indicated above relative to some of the other Jilat assemblages. However, this is not likely to be the complete explanation as other Jilat assemblages, notably J26, have a similar range of harder hammer indices.

The general importance of softer hammer use in these assemblages, except J25, is clear. Even at J25 softer hammer use had a significant role. At the Azraq 31 occupations softer hammer use undoubtedly dominated. This leaves us with the question of why the differences in the softer and harder hammer indices exist. Harder hammer use was almost certainly more common in the Jilat sites but was it considerably more important than the harder hammer indices themselves might suggest i.e. were they the techniques responsible for the generation of the considerable proportion of blade-bladelet debitage undiagnostic as to technique? Do the differences on the other hand reflect variation in the softer hammer techniques actually used? The facetting of the platform itself was very rare. This may suggest that the technique distinctions between the Azraq 31 occupations and those in Jilat were not merely a reflection of greater use of softer or harder hammer techniques. There is, however, a disproportionate occurrence of harder hammer stigmata on platforms with platform facetting, in the samples used here 35 platforms with facetting on the platform have lips and 17 have clear cones and points of percussion, Siret fractures or ring cracks. Thus, even this distinction may be based on the greater use of softer hammer techniques at Azraq

Section 6.8.4 Summary of technique as observed on blade-bladelet debitage.

The Azraq 31 occupations are distinct from those in Jilat. They have very high softer hammer indices, almost all platforms are very small, the incidence of the preparation of the platform edge on the main removal surface is high; specific small areas on the platform edge were clearly targeted for impactors. On the other hand the facetting of the platform itself was very rare. Even this distinction may be based on the greater use of softer hammer techniques at Azraq.

At J25 softer hammer use was probably important, but harder hammer techniques were probably important as well. Platforms were relatively large and a relatively high proportion cortical. Removal surface preparation was very rare.

On the other Jilat sites softer hammer technique(s) were certainly important, but harder hammer techniques may also have been relatively important. Harder hammer techniques may have been somewhat more important than on these other Jilat occupations on J7 Phase I, J26 and J13 Phase I. A high proportion of platforms are relatively small except on J13 Phase I. Platform preparation on the edge of removal surfaces was relatively common on the J7 occupations, somewhat less common on the other Jilat sites. Idiosyncratic techniques may be represented by the higher proportions of winged platforms on J32 and J13 Phase I - these represent a succession of removals from the position on the platform edge.

Section 6.9 General summary of technology.

A brief reconstruction of technology is offered occupation by occupation and then a summary of major developments through time is indicated.

In the 8th M.b.c. Early PPNB at J7 single platform and change of orientation strategies dominate (table 6.7). Naviform strategies are present but infrequent. Tabular edge preparation methods are present for the preforming of naviforms and possibly other types. A very diverse range of strategies are indicated by core types, amongst which those which produced small prismatic and pyramidal cores are particularly important (section 6.5.1). Wadi cobbles were preferred and very high proportions of exotic red material were imported to Jilat (section 6.6.3). The presence of crested blades and rejuvenation elements and cortical flakes of exotic red material suggests that most stages of production were carried out on site. The small size of cores is to be related to the importance of bladelet production (sections 6.5.2 and 6.7.1-6.7.2). Debitage and cores indicate a significant degree of platform and removal surface preparation, particularly given that coarse platform facetting would not be reflected on debitage with small platforms (section 6.5.4). Softer hammer techniques were important but there may have been a relatively important role for harder hammer techniques as well (sections 6.8.2.-6.8.3.).

At Middle PPNB J7 Phase II opposed platform strategies have become much more important and naviform strategies *sensu lato* dominate (section 6.5.1). Prismatic cores are also important. Exotic red material is present but may be residual (section 6.6.3).

Blade production was the object of these strategies (sections 6.7.1-6.7.2). Cores and debitage indicate a considerable degree of platform preparation both on removal surface and platform proper (section 6.5.4). Softer hammer techniques were relatively important but harder hammer techniques were present in significant proportions (sections 6.8.2.-6.8.3.).

At Middle or Late PPNB J7 Phase III opposed platform strategies continue to be the most important. Naviform strategies are important, but prismatic strategies are also important and tabular edge strategies too have a significant role. Tabular raw material is preferred (section 6.5.1). Relatively large (by Jilat standards) blade debitage is produced (section 6.7.2). Cores and debitage suggest that platform preparation is significant (sections 6.5.4 and 6.8.2.). Softer hammer use was relatively common although harder hammer use certainly had a role (sections 6.8.2.-6.8.3.).

At Middle PPNB J26 (possibly later than J7 Phase II) opposed platform strategies were very important of which naviform strategies dominated (section 6.5.1). Amongst these naviforms tabular edge strategies were important and tabular edge non-naviform strategies were also important (section 6.5.1). A very dramatic preference for tabular raw material existed (section 6.6.3). Small amounts of exotic translucent yellow material were also used (section 6.6.3). Blades were the preferred product, possibly relatively large (sections 6.7.1-6.7.2, 8.2 and 8.5). Cores and debitage suggest that removal surface and platform preparation were moderately important with distinct intra-site variation in this regard (sections 6.5.4 and 6.8.2.). Softer hammer use was relatively important but harder hammer use may have been more significant than at many other Jilat sites (sections 6.8.2.-6.8.3.).

At Middle or Late PPNB J32 opposed strategies were in the majority. Naviform strategies dominated but the sample of cores was particularly small (section 6.5.1). Extra efforts were made to procure tabular material at a distance (section 6.6.3). Blades were the preferred product (sections 6.7.1-6.7.2). Cores suggest that both types of platform preparation were frequent in naviform strategies but not others (section 6.5.4); the moderate amount of debitage with platform facetting presumably derives from naviform production (section 6.8.2.). Softer hammer production was probably relatively important (sections 6.8.2.-6.8.3.).

At Early Late Neolithic J13 Phase I single platform and change of orientation strategies are now important; naviform strategies still play a role but they are considerably reduced in importance (section 6.5.1). Cobble, tabular edge and prismatic strategies are now important (section 6.5.1). Tabular raw material is still preferred (section 6.6.3). Occasional use of exotic translucent yellow raw material (section 6.6.3). Blades appear to be the preferred product although bladelet and flake production may be more important (sections 6.7.1-6.7.2). Cores suggest that platform preparation of both types was higher on naviforms, lower on other types. Its moderate occurrence amongst the debitage may be taken to indicate the derivation of the debitage from a variety of strategies (sections 6.5.4 and 6.8.2.). Softer hammer techniques were important, but harder hammer techniques may have been somewhat more important than at some other Jilat sites (sections 6.8.2.-6.8.3.).

At Early Late Neolithic J13 Phase II single and change of orientation strategies now dominate completely, naviform strategies *sensu stricto* have a minimal presence and may only be represented by residual pieces (section 6.5.1). There is a wide range of strategies, prismatic, pyramidal, tabular edge and cobble (section 6.5.1). Interest has switched to only immediately available or wadi raw material (section 6.6.3). Exotic translucent yellow material is present in small proportions (section 6.6.3). Blades are the preferred product (sections 6.7.1-6.7.2). Cores and debitage indicate low frequency of preparation of the striking platform and moderate preparation of the main removal surface (sections 6.5.4 and 6.8.2.). Softer hammer techniques were relatively important although harder hammer were certainly present (sections 6.8.2.-6.8.3.).

At Early Late Neolithic J25 (probably later than J13 Phase I), single and change of orientation strategies dominate completely (section 6.5.1). Naviform cores *sensu stricto* are absent and only a very few cores indicating derived naviform strategies were employed with low frequency - sub-naviform cores. Prismatic and cobble strategies dominate, but pyramidal and tabular edge have an important role (section 6.5.1). Interest has switched to only immediately available or wadi raw material for the most part, but extra efforts were made to procure tabular material for some opposed platform production (section 6.6.3). Exotic red raw material also occurs in low proportions (section 6.6.3). Flake production was much more important, although blades were still desired end products (sections 6.7.1-6.7.2). Higher proportions of cortical platforms on cores and debitage strongly indicate an overall reduction in core preparation strategies as well as the lower frequency of technique related preparation also attested by lower platform preparation of both types on cores and debitage (sections 6.5.4 and 6.8.2.). Whilst softer hammer techniques still played a significant role, J25 has evidence of the greatest frequency of harder hammer use (sections 6.8.2.-6.8.3.).

At Azraq 31 Late PPNB opposed platform strategies dominate. Naviform strategies are the most important but tabular edge strategies are also important (section 6.5.1). Tabular raw material was utilised (section 6.6.3). An exotic white material was present, not represented by cores. Blades were the object of production and particularly long blades are present on the site notably as tools (sections 6.7.1-6.7.2). These blades are considerably longer than any cores on site (including any from the Late Neolithic). There are dramatic contrasts between the cores and debitage in terms of evidence for platform preparation, particularly of the main removal surface (sections 6.5.4 and 6.8.2.). The latter is poorly represented on cores, even naviform cores - forming a notable contrast with Jilat cores. Yet it is much higher on blade-bladelet debitage than on equivalent debitage from Jilat sites (sections 6.5.4 and 6.8.2.). Platform facetting is very low on blade-bladelet debitage but relatively high on naviform cores compared to Jilat sites (sections 6.5.4 and 6.8.2.). Cortex is much lower on platforms of cores at Azraq 31 but similar on blade-bladelet debitage to the situation on the Jilat sites (sections 6.5.4 and 6.8.2.). The use of techniques represented by both cores and debitage is distinct from that represented most frequently in Jilat. Perhaps significantly there is a suggestion that a proportion of the blade-bladelet debitage deposited on the site may have been produced elsewhere. The particularly long blades recovered may be one component of such debitage. There are hints that they may have entered the site hafted as tools, for example fig. 8.6:2, hafted with bitumen, closest available source the Dead Sea. At least part of these technique contrasts between Jilat and Azraq 31 are that softer hammer techniques were more important and harder hammer use relatively rare (sections 6.8.2.-6.8.3.).

At Late Neolithic Azraq 31 opposed platform strategies still dominate. Naviform cores were still the most important core class, but edge of tabular bifacial cores were also important as were prismatic and tabular edge strategies (section 6.5.1). Tabular raw material was still important but in contrast to the PPNB at Azraq 31 lower quality chert cobbles were also used for flake production (section 6.6.3). An exotic white material is present, not represented by cores (section 6.6.3). Blades were an important product (sections 6.7.1-6.7.2). A very similar contrast in terms of technique indicators to that in the PPNB at Azraq 31 exists between cores and blade-bladelet debitage and at the same time between Azraq and Jilat cores and blade-bladelet debitage (sections 6.5.4 and 6.8.2.). The indication is that techniques were very similar to those in the Late PPNB. Softer hammer techniques dominated, harder hammer were rare (sections 6.8.2.-6.8.3.).

Section 6.10 Key developments in production technology and their implications.

1) Naviform strategies form a small component of the 8th M.b.c. Early PPNB assemblage, they increase dramatically in importance by the beginning of the 7th M.b.c. in the Middle PPNB and dominate the 7th M.b.c. assemblages (section 6.5.1). They persist as a small but significant component of the earliest Late Neolithic assemblages with transitional features at J13 Phase I and probably Azraq 31 Late Neolithic, where however they may still be important. The picture is complicated by the possibility of some residuals amongst a relatively small sample (section 6.5.1). Technological change is clearly rapid in the Early Late Neolithic. At J13 Phase II true naviforms are rare and possibly represented only by residuals. At J25 and therefore probably at J13 Phase II (section 6.5.1), sub-naviforms represent the meagre continuance of naviform related strategies with much less initial core preforming. The rapidity of change is indicated by the fact that these developments are all confined to the early 6th M.b.c.

2) The rise and decline of naviform strategies are precisely correlated with the importance of opposed compared to the clearly inter-linked single platform and change of orientation strategies (section 6.5.1). In their 8th M.b.c. Early PPNB setting these latter are important, throughout the 7th M.b.c. they are unimportant and they rise in importance in the early 6th M.b.c. as naviforms disappear (section 6.5.1).

3) Naviforms, and therefore presumably naviform strategy, remain a very homogeneous phenomenon throughout the period, well over a millennium of uncalibrated radio-carbon

years, and locus of their use, whether an important part of reduction strategies or not. This homogeneity occurs regardless of raw material used. It is reflected in size at deposition and as far as can be ascertained, as preforms. It is also reflected by preforming methods, including the particular tabular edge methods shared with tabular edge strategies, platform preparation relative to other core types, final position of crest relative to main removal surface (suggested by Calley 1986b as of potential chronological significance), platform angles and main debitage product.

4) Desired debitage products must be assessed on tool blank types (sections 8.2-8.5) as well as proportions of debitage types and key debitage products indicated by main removal surfaces on cores. These indices in conjunction indicate the following: in the 8th M.b.c. bladelets were important, throughout the 7th M.b.c. and into the early 6th blades were the preferred and numerically dominant product. Flake production may be becoming more important in the early 6th M.b.c., certainly at J25, possibly at J13 Phase I. At J25 the indication is, that whilst blades were a desired product (for tool blanks), interest in maximizing their production had declined.

5) Whilst it is difficult to assign specific techniques to particular strategies, technique seems to vary, at least partly, independently of strategy and strong geographical contrasts are evident. Throughout the Jilat sequence from Early PPNB to Early Late Neolithic, regardless of whether naviforms are important or not, regardless of the relative importance of single platform and change of orientation strategies, relatively similar factors pertain as evidence of techniques. Thus in Jilat with the exception of J25, softer hammer techniques are important but harder hammer techniques have a clear role. In some assemblages harder hammer techniques may be slightly more important, but they include naviform dominated Middle PPNB (e.g. J26) and Early Late Neolithic assemblages like J13 Phase I. Platforms are of similar sizes, naviform cores always show

more platform preparation than non-naviform and preparation indices on debitage are relatively similar. The assemblage on J25 may mark a departure, with harder hammer use more significant and core and platform preparation of reduced importance, platforms are relatively large. It is the only assemblage in which flakes dominate and cores suggest flake production was desired.

6) Dramatic geographical contrasts in technique traditions may be apparent. If a Jilat tradition of techniques may exist, it persists with minor variations from 8th to early 6th M.b.c. possibly to change at some point in the Early Late Neolithic. A clearly contrasting tradition exists at Azraq 31 from at least Late PPNB into Early Late Neolithic. This contrast includes the import of tools and probably blade-bladelet debitage into Azraq 31 in Late PPNB and Late Neolithic.

7) The study of raw material procurement and reduction strategy suggests that raw material was used selectively for different strategies. It suggests that procurement was carried out selectively and that immediate availability did not condition the reduction strategies. It suggests that extra effort may have been expended on obtaining preferred materials to different degrees depending both on site setting production environment and individual community preferences. There is no clear chronological pattern in the development of such preferences. There is, however, a distinct fall in interest in importing significant quantities of exotic and potentially more costly (in terms of energy invested in obtaining them) raw materials after the 8th M.b.c.

8) There is considerable evidence for general technological variability that cannot be assigned to part of directional change through time. Relative to the situation in Jilat there is some evidence that some sites had more harder hammer use and others less. Those with harder hammer use include J26 which is coeval with or bracketed by the

Phase II and III occupations on J7 with their lower harder hammer indicators. J13 Phase II in the Early Late Neolithic has fewer harder hammer indicators but preceding J13 Phase I and coeval J25 has more harder hammer indicators. Variation in procurement preferences and strategies have already been mentioned. Platform preparation does not develop in any clear direction through time, other than to say because of its strong association with naviforms it becomes less frequent because they do, but not necessarily on non-naviforms.

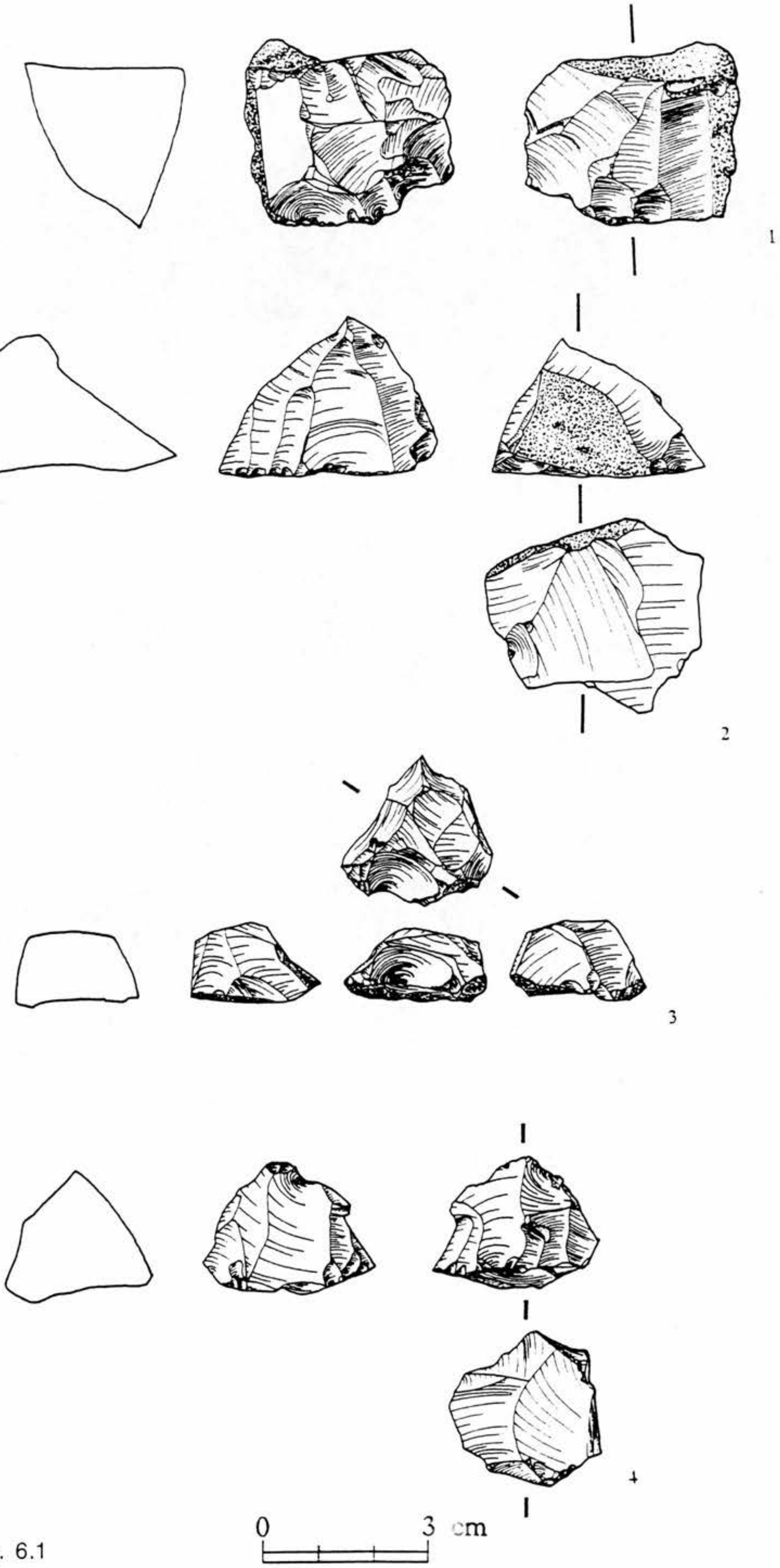
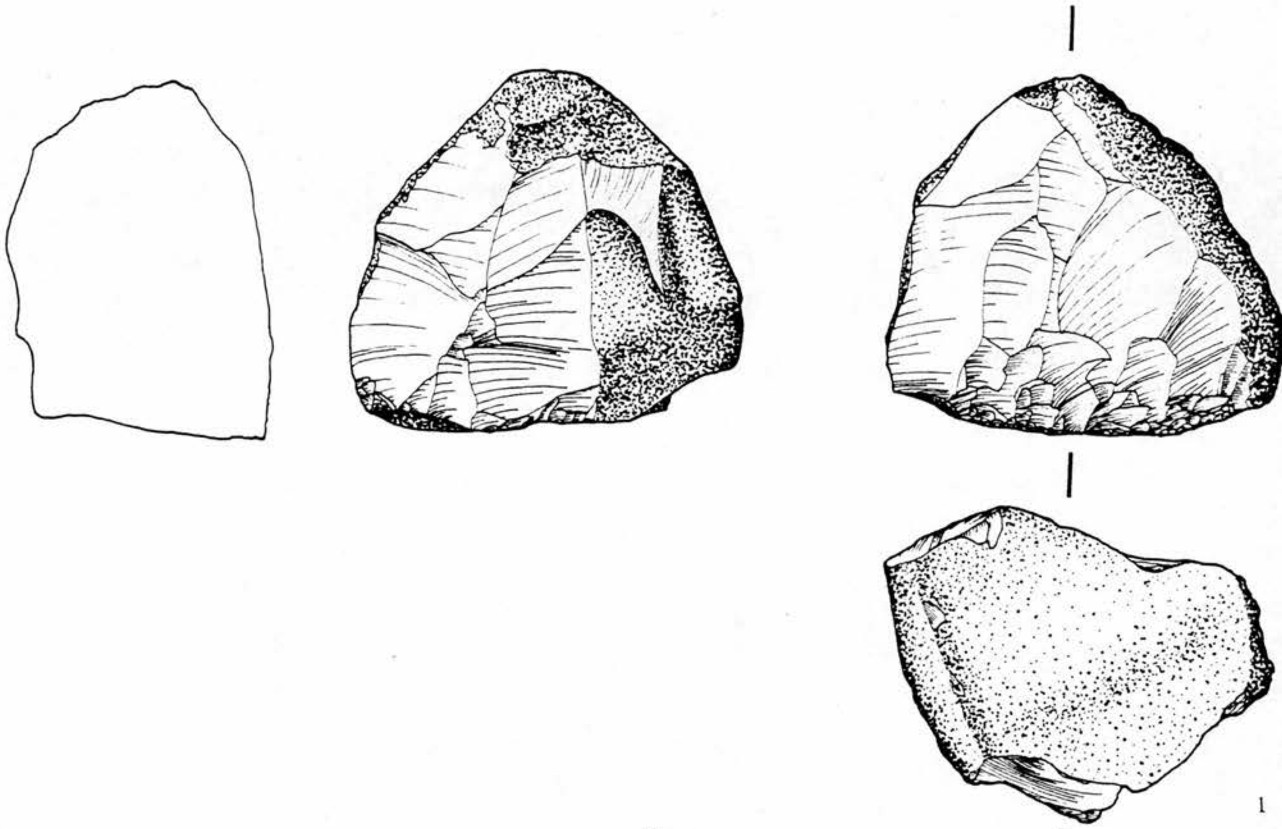


Fig. 6.1



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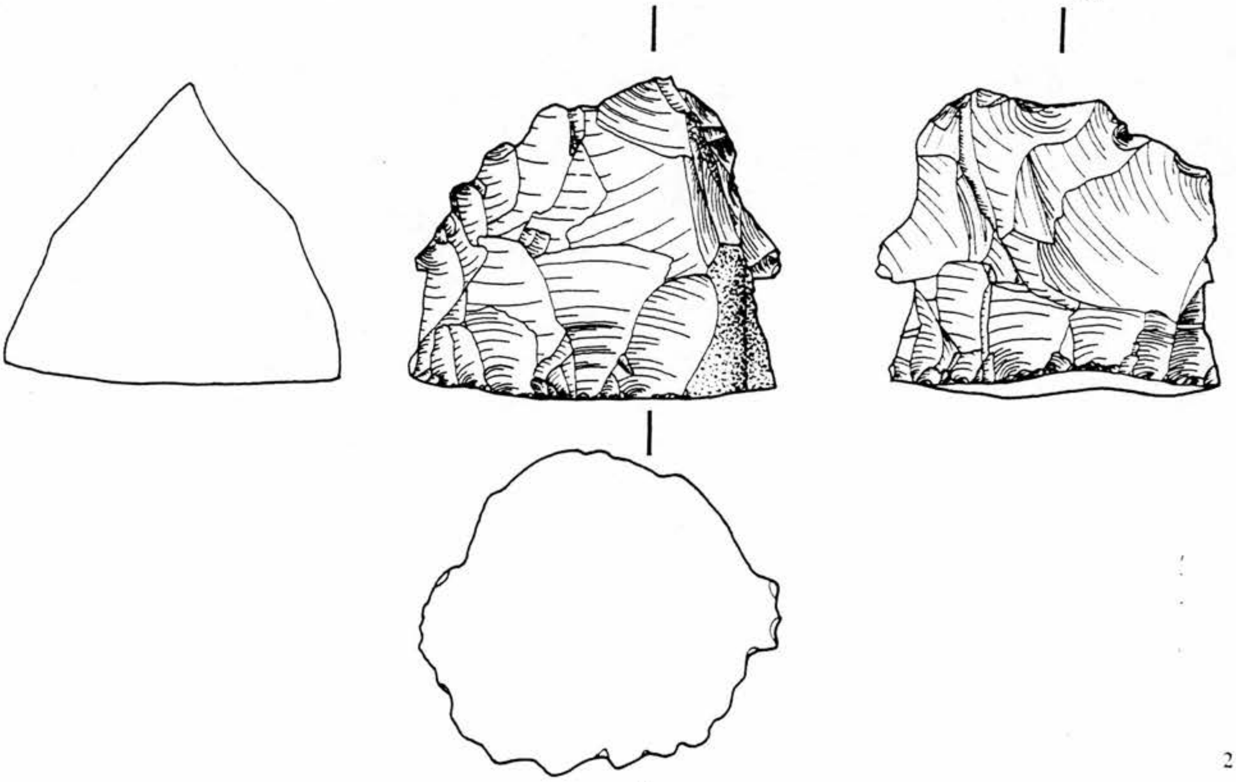
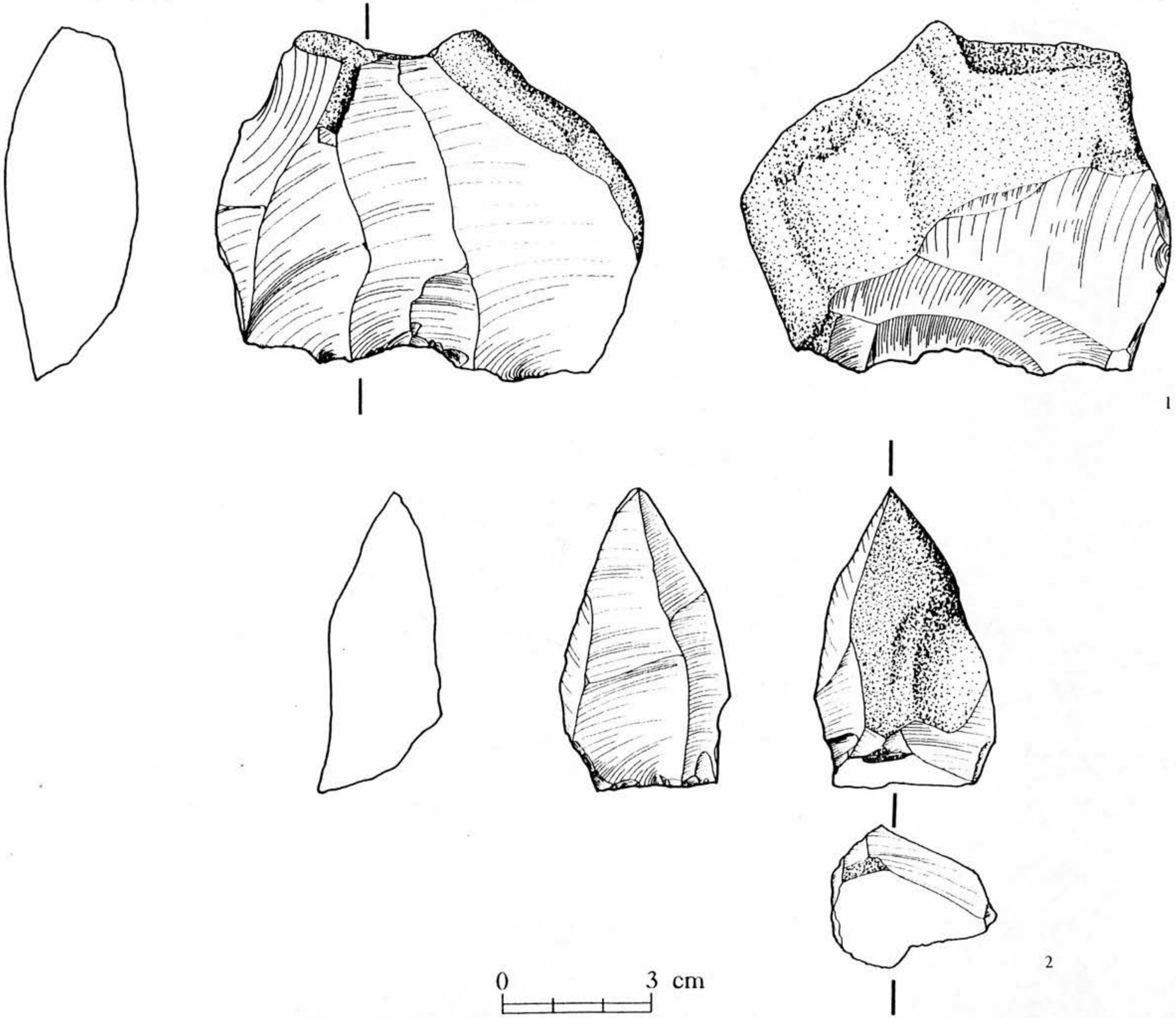


2

Fig. 6.2

Fig. 6.3



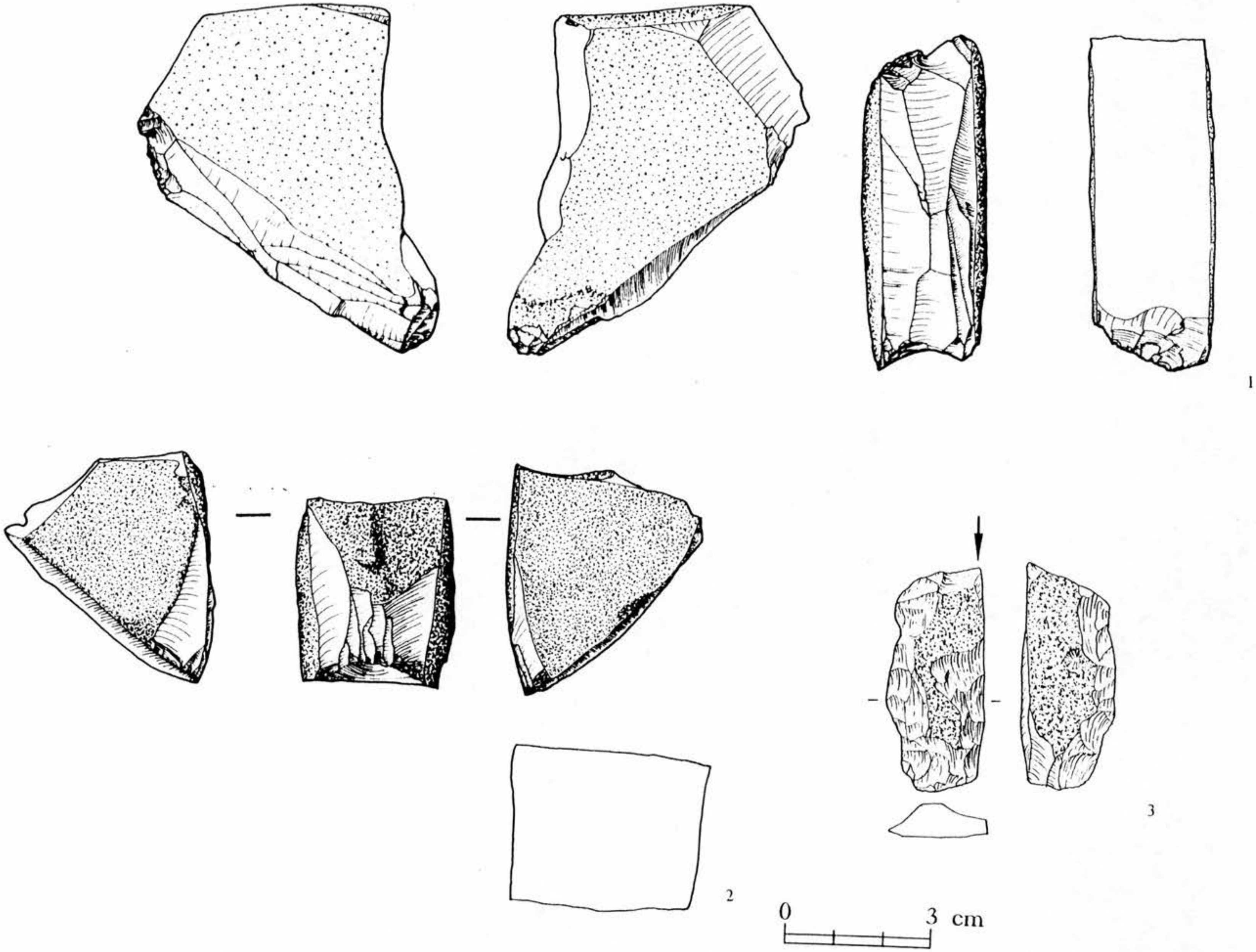


Fig. 6.4

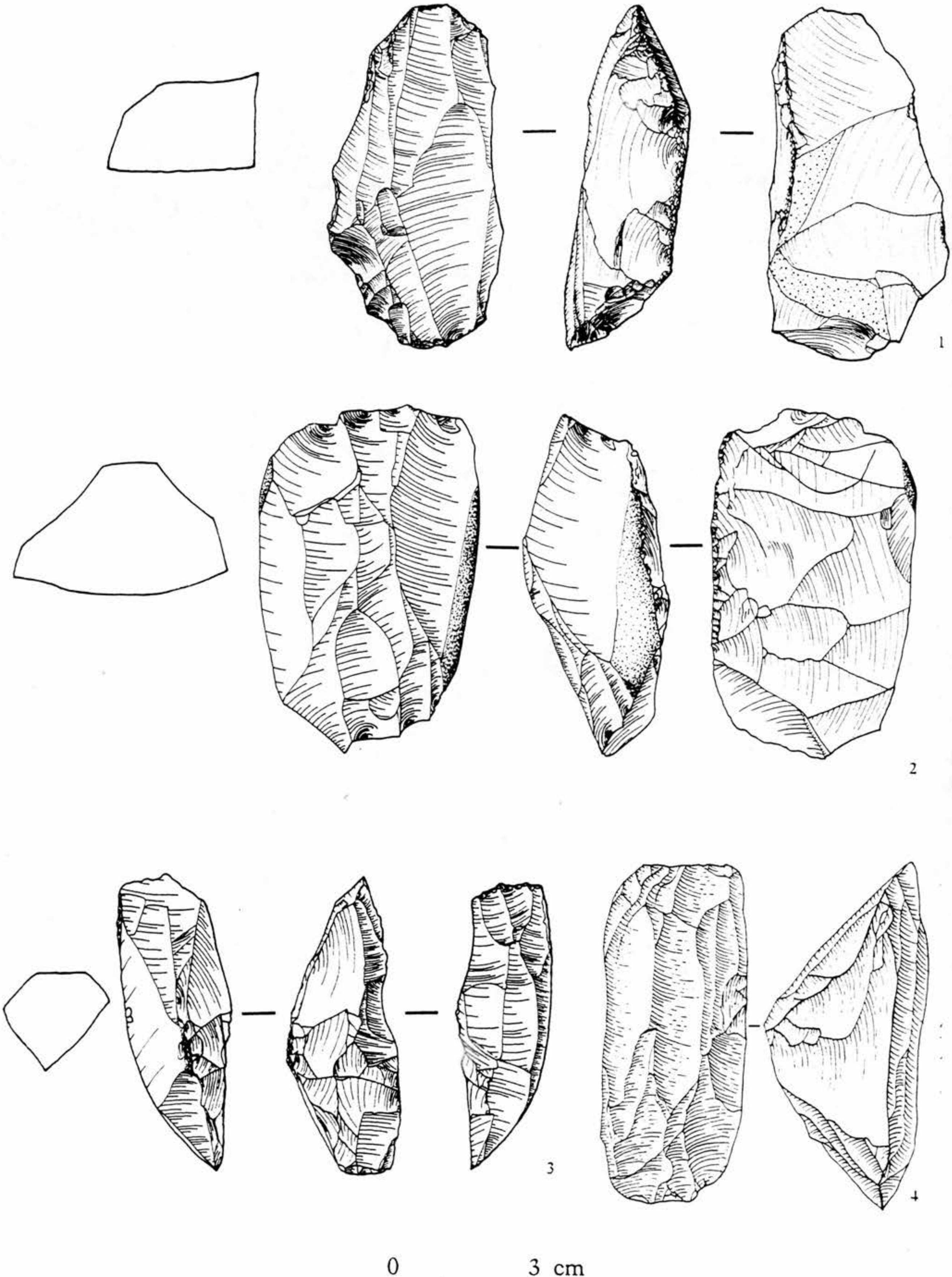


Fig. 6.5

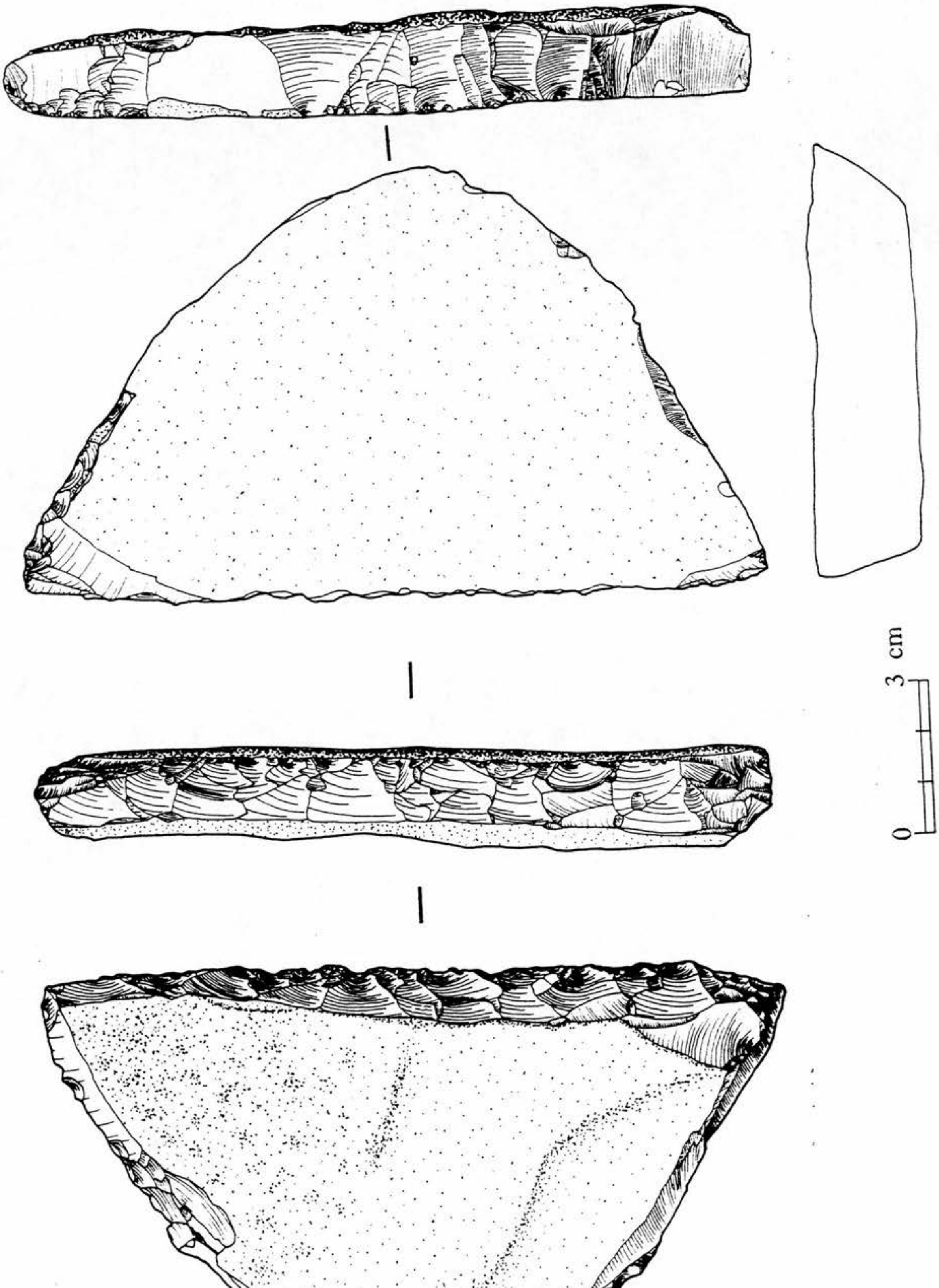


Fig. 6.6

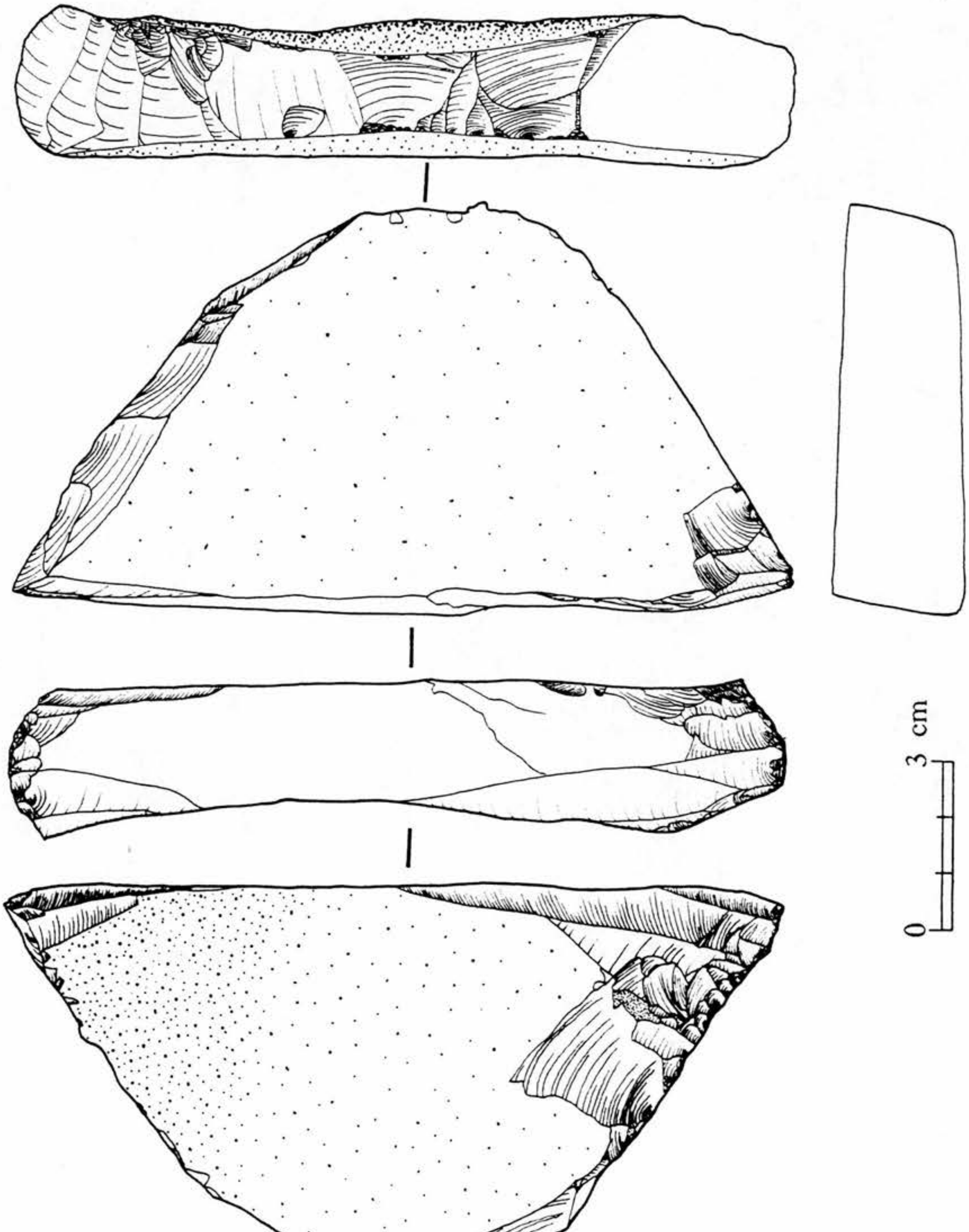


Fig. 6.7

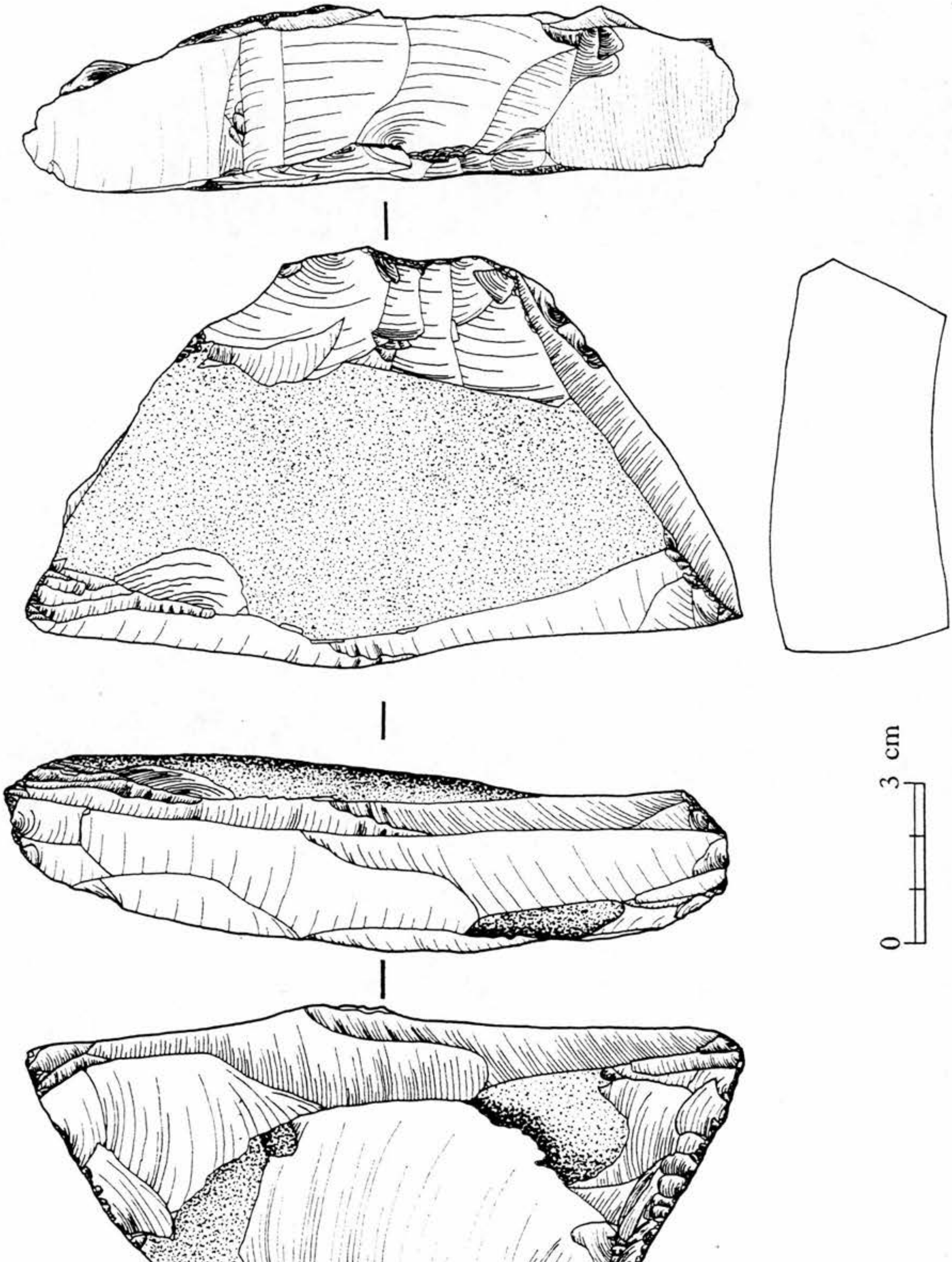


Fig. 6.8

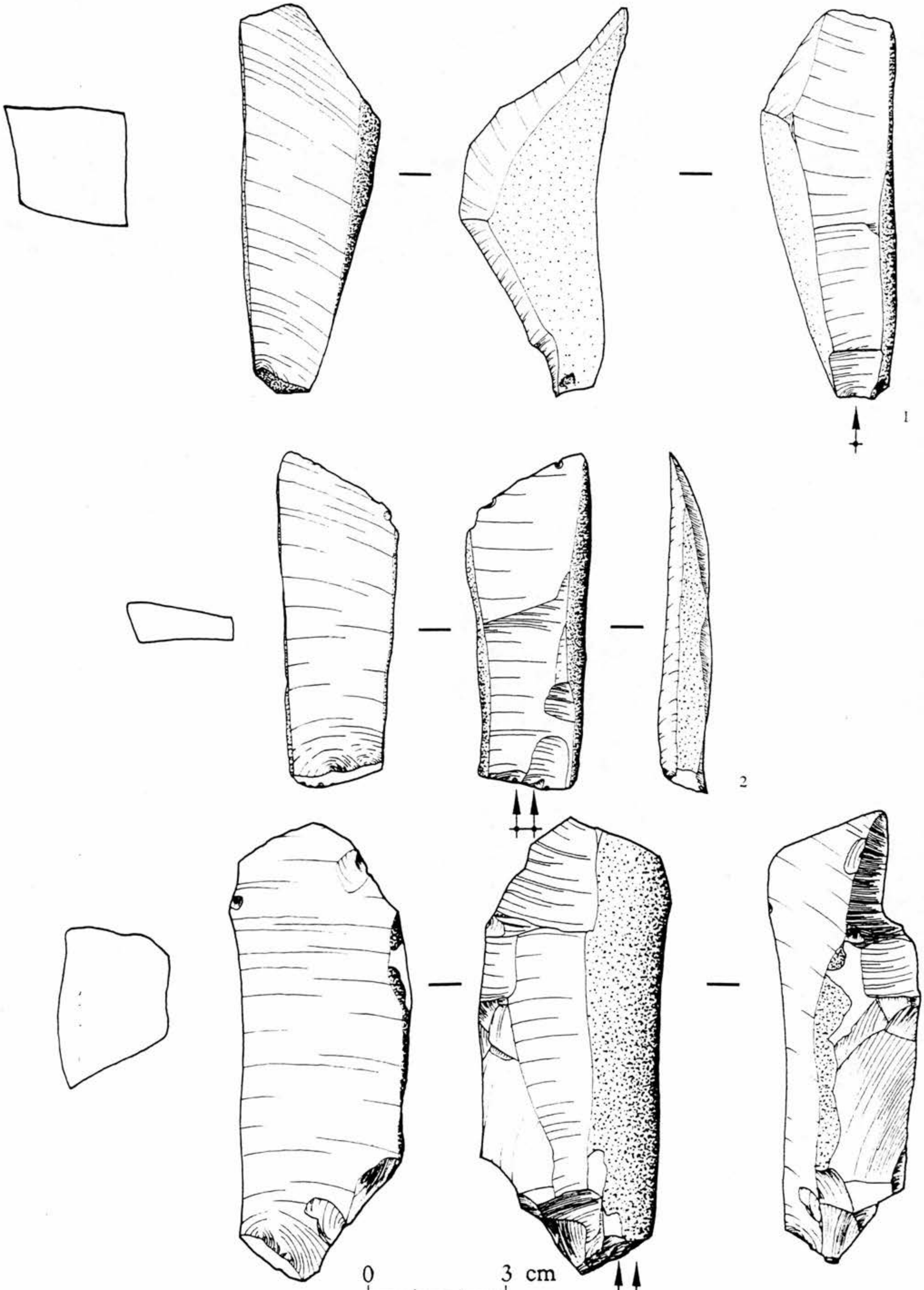


Fig. 6.9

Fig 6.10: Wadi Raw material
Length:Width

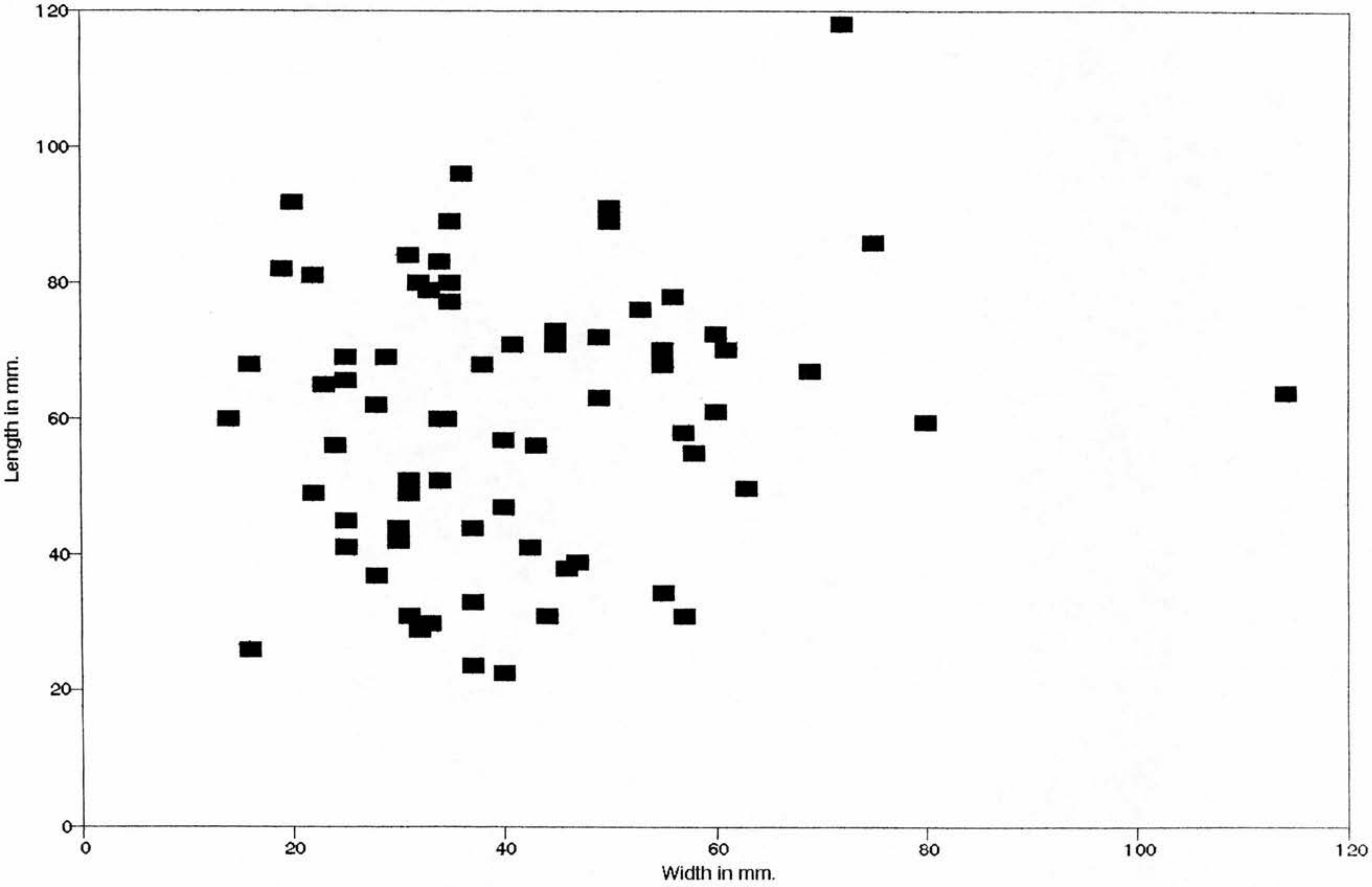


Fig 6.11: Tabular Raw material
Length:Width

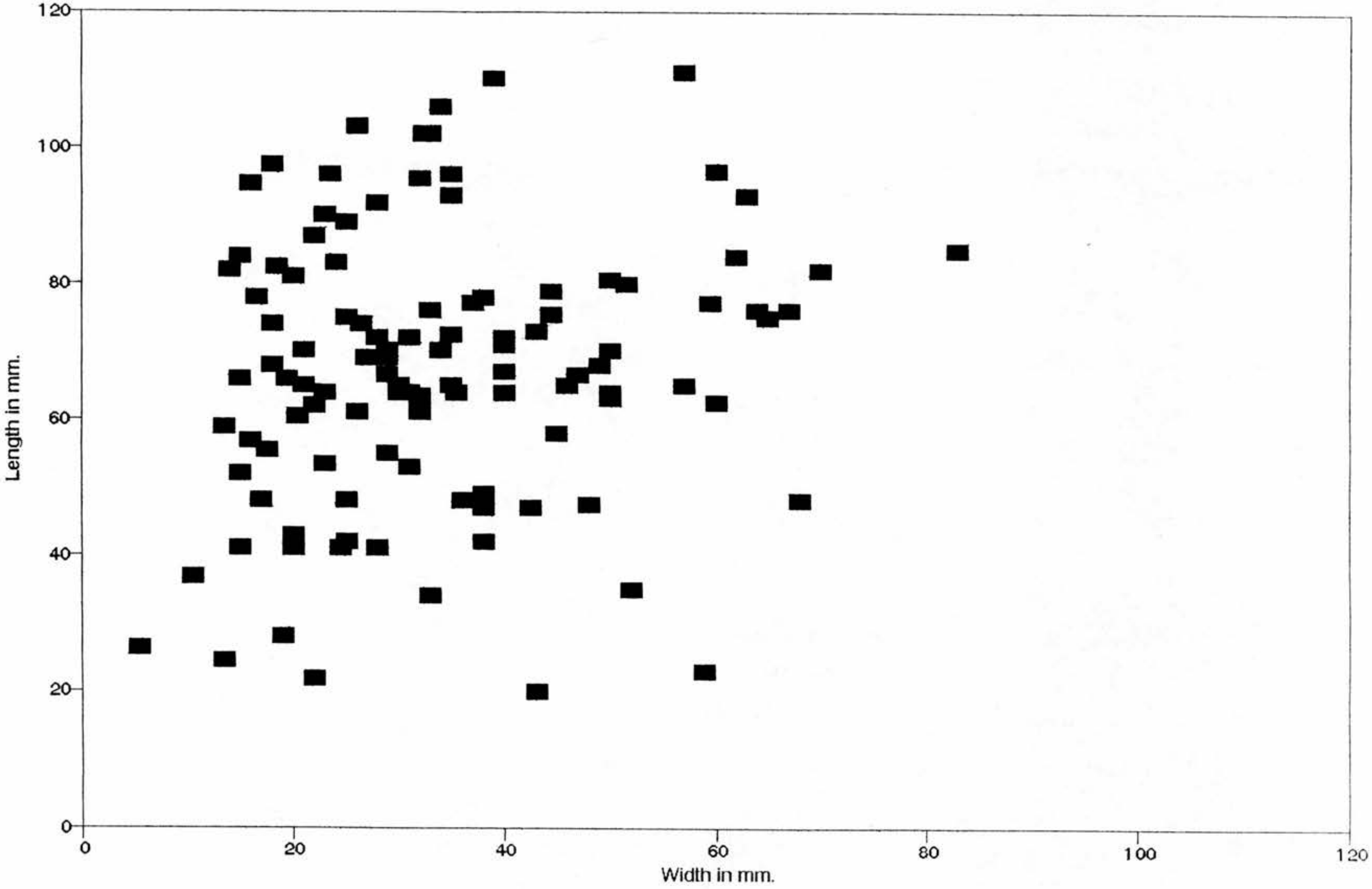


Fig 6.12: Exotic Raw material
Length:Width

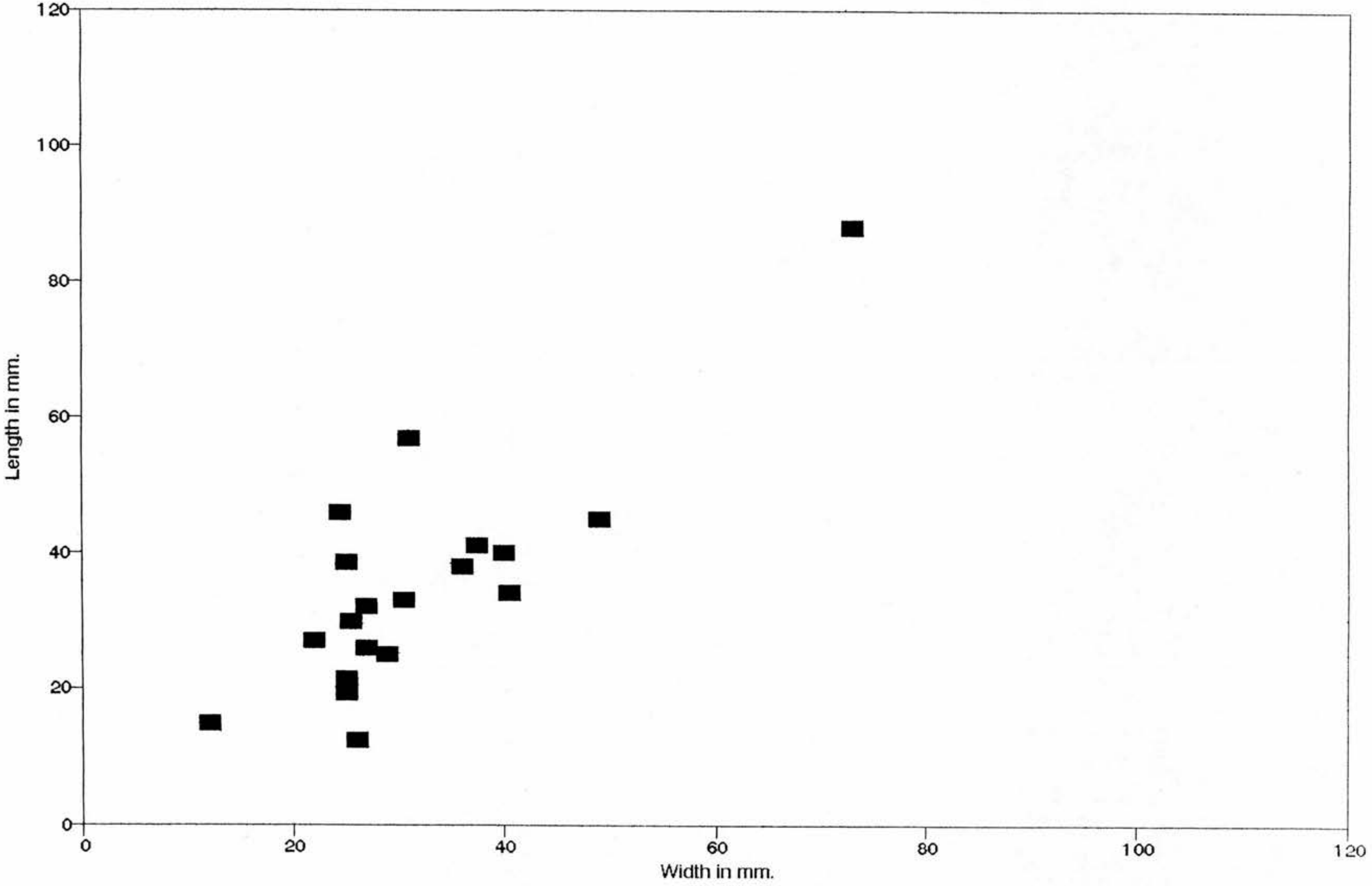


Fig 6.13: Wadi Raw material
Thickness:Width

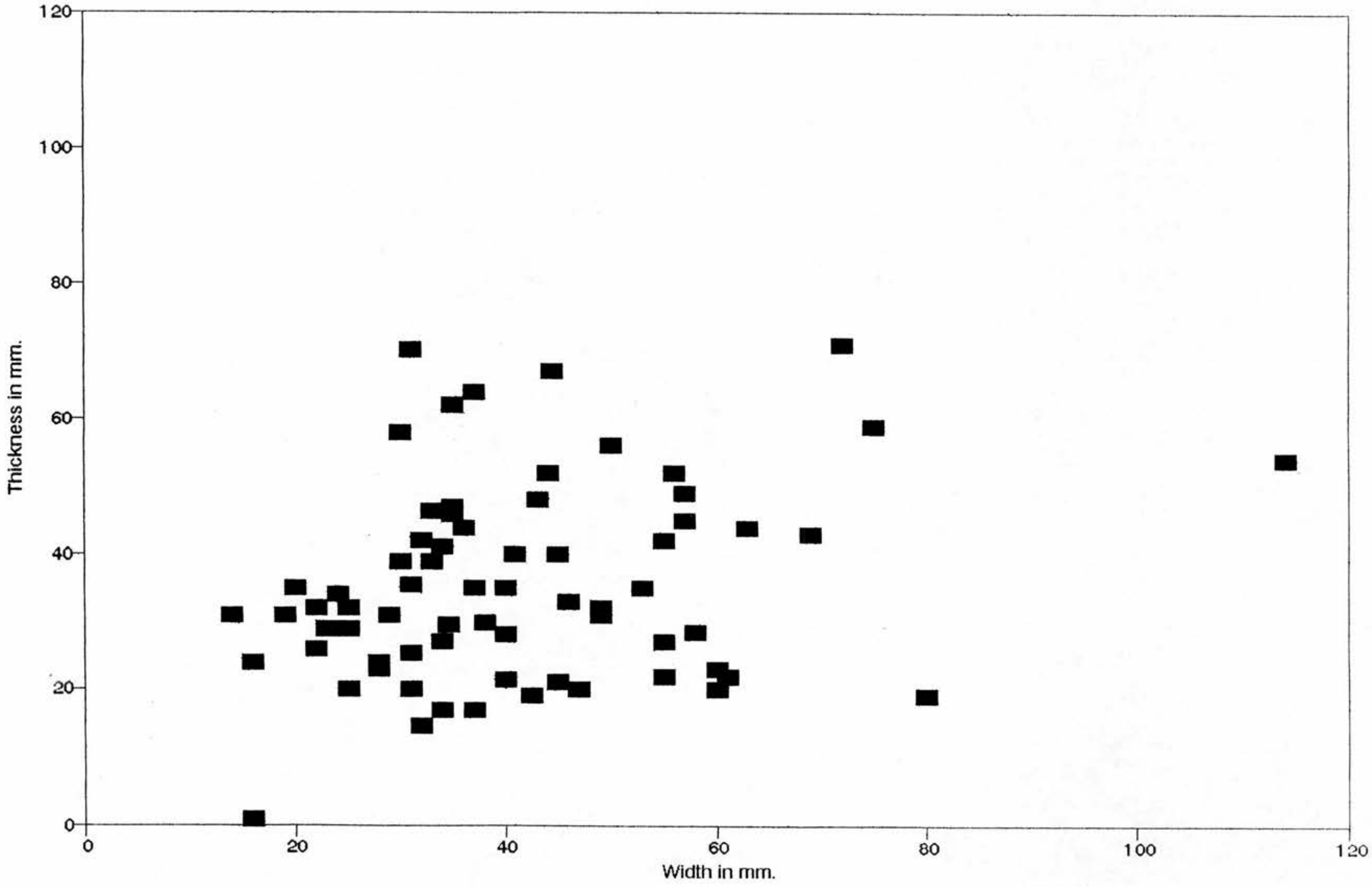


Fig 6.14: Tabular Raw material
Thickness:Width

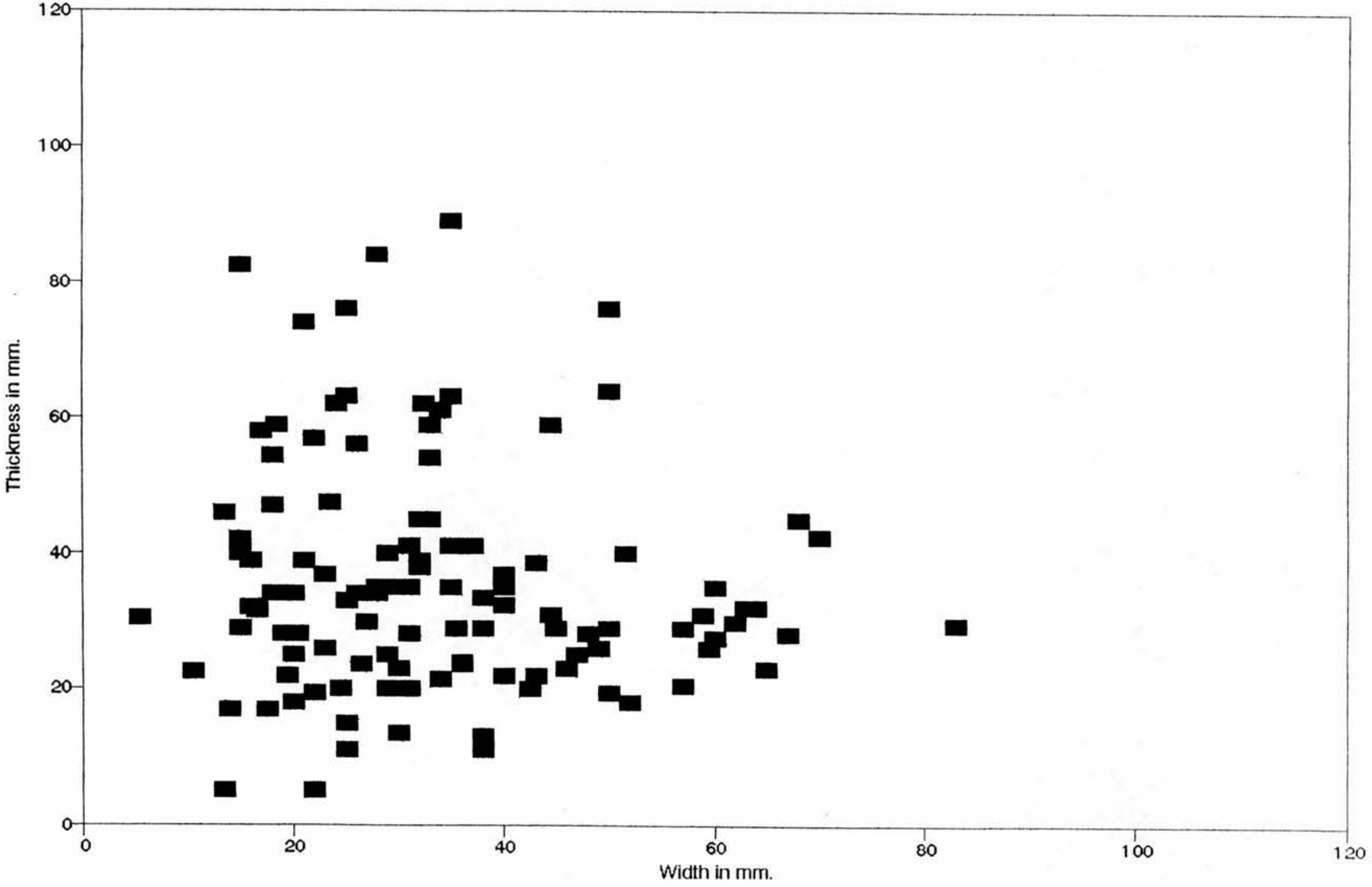


Fig 6.15: Exotic Raw material
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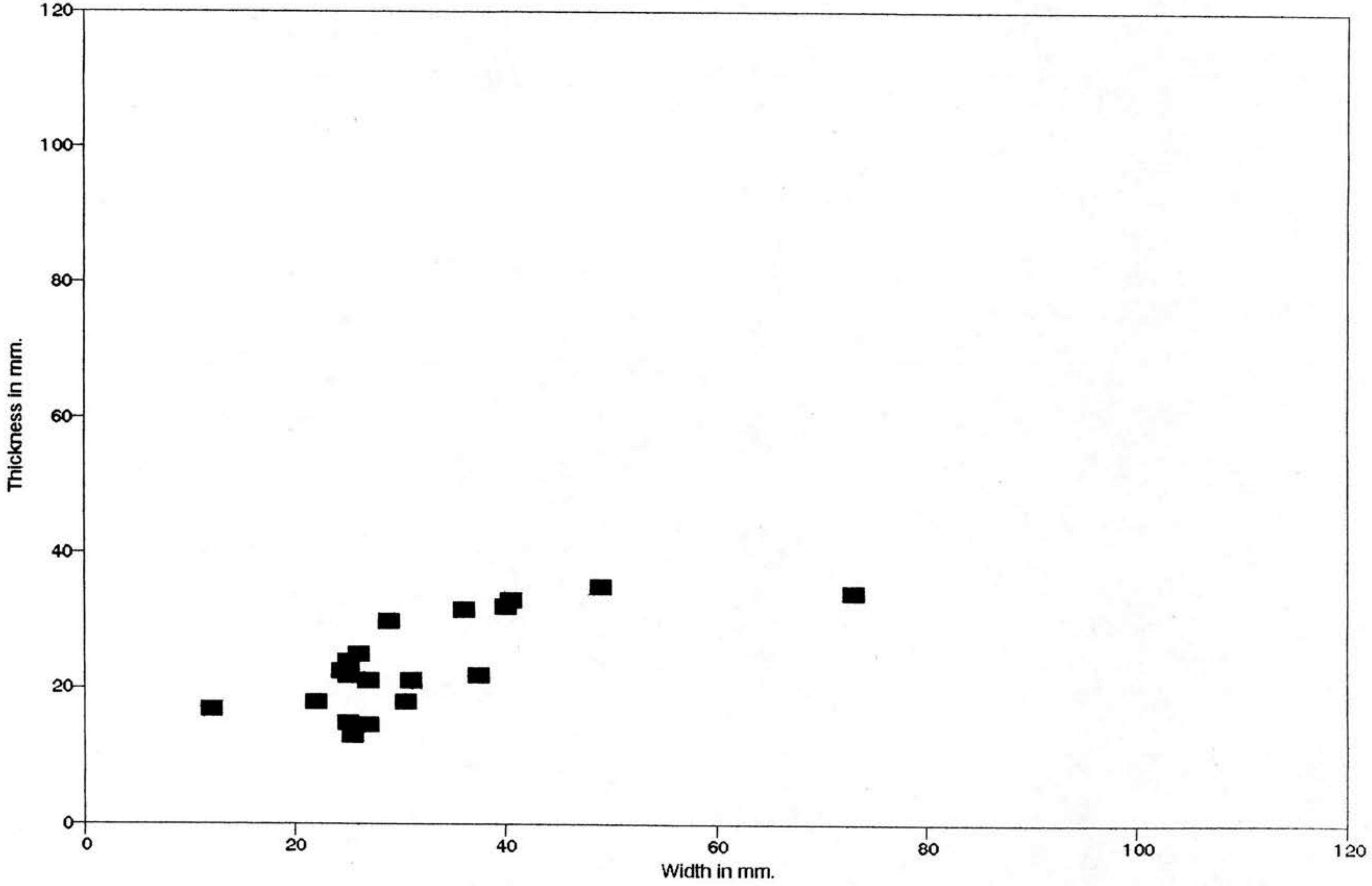


Fig 6.16: Preform cores
Length:Width

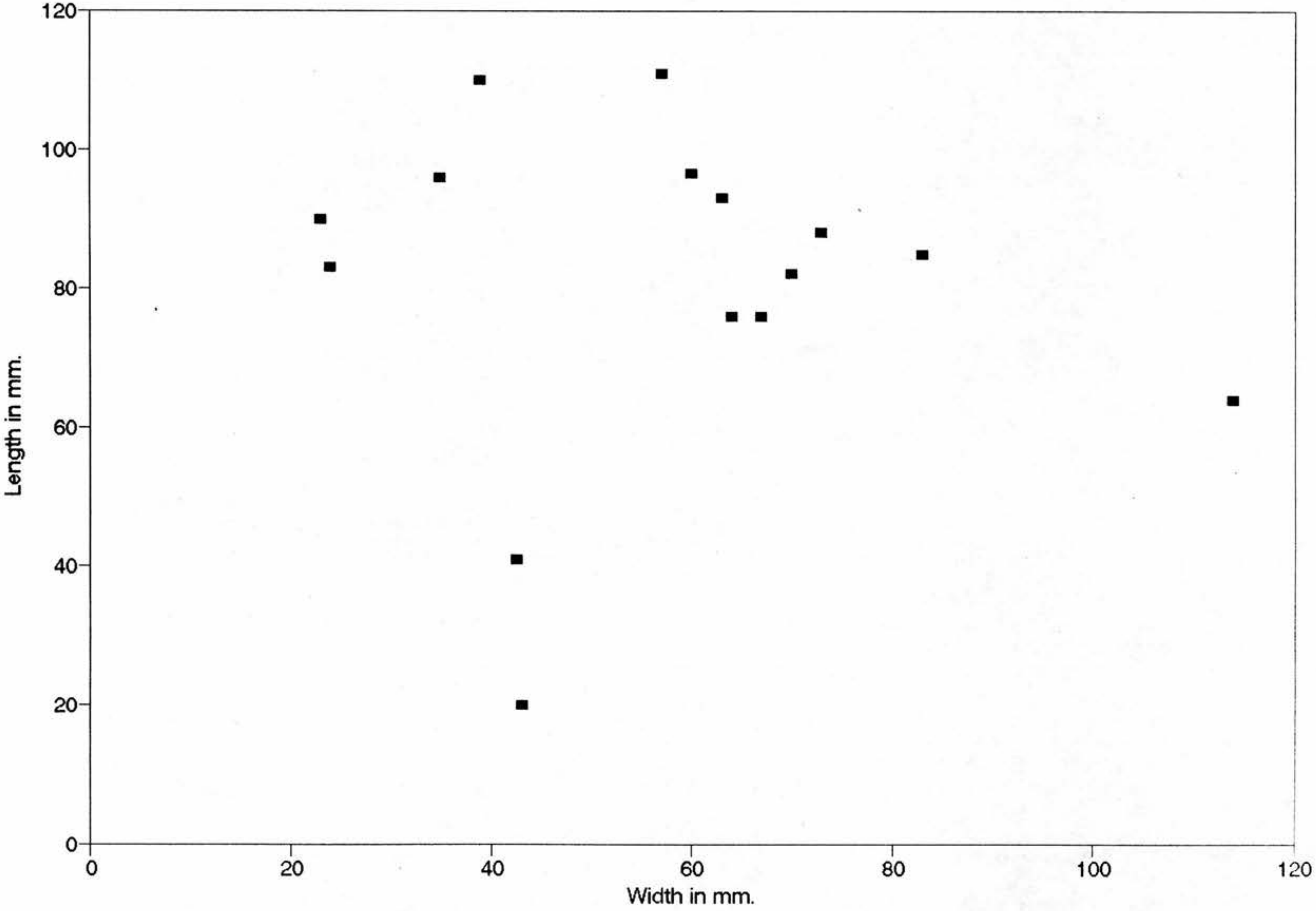


Fig 6.17: Single platform cores
Length:Width

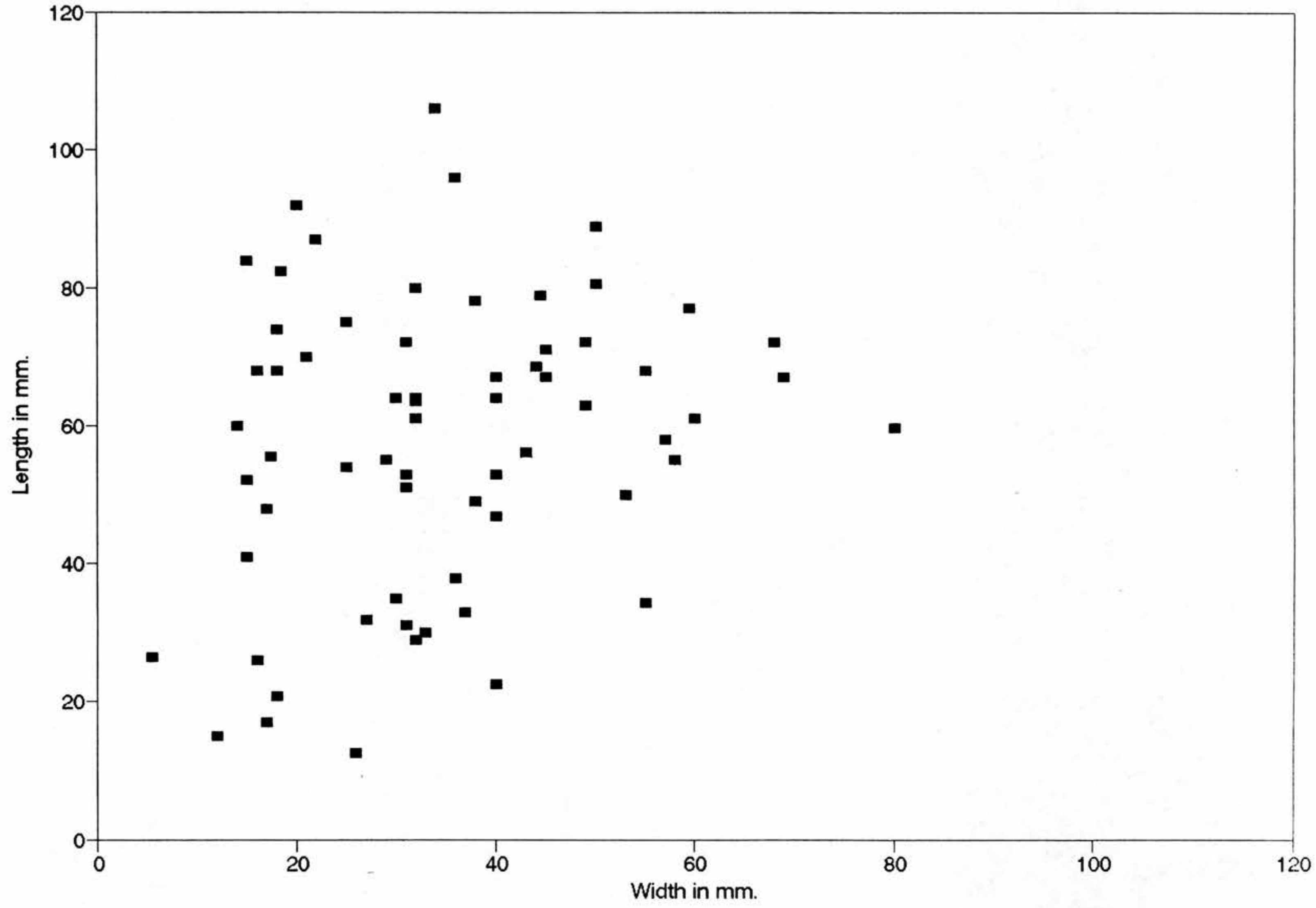


Fig 6.18: Opposed platform cores
Length:Width

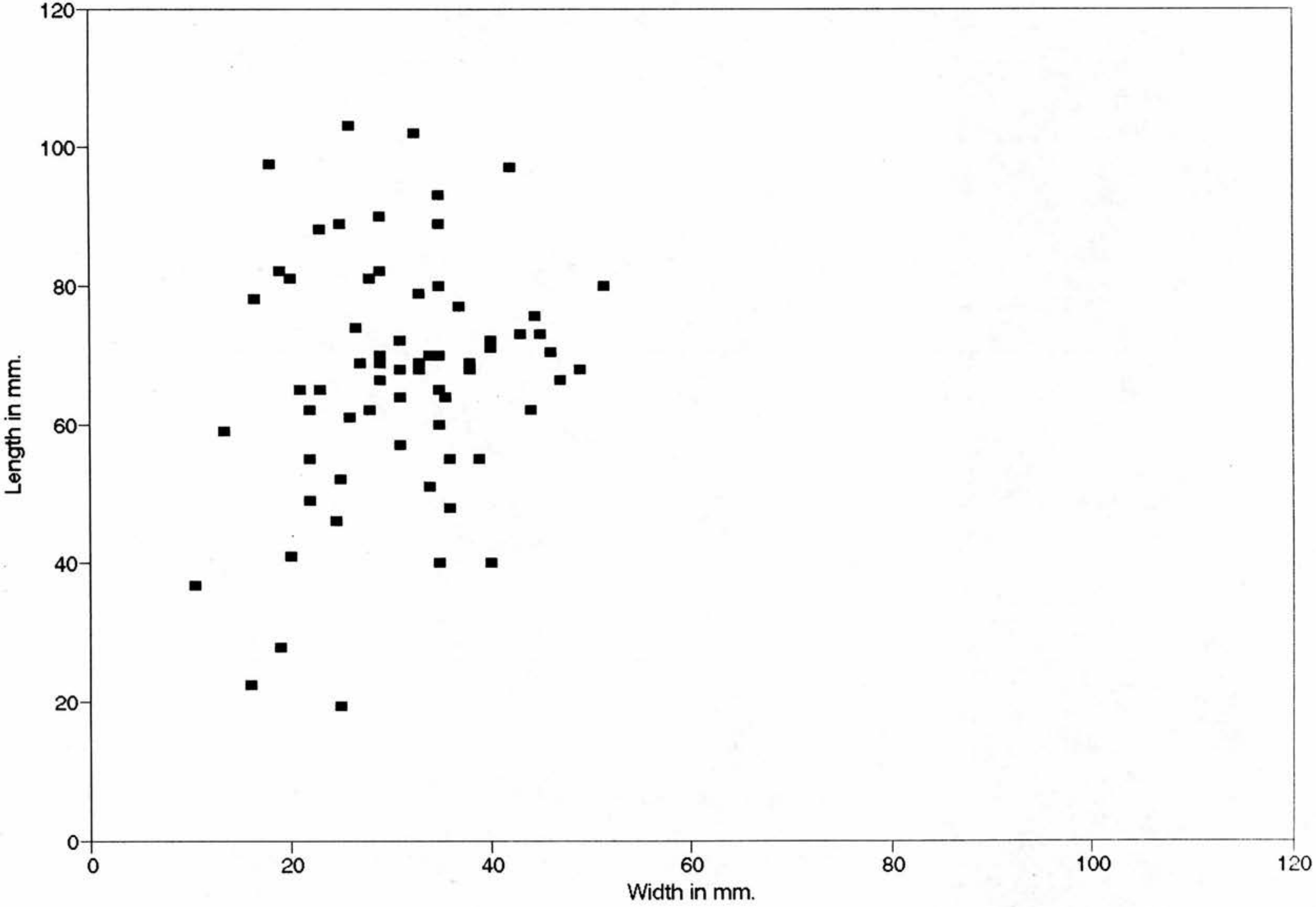


Fig 6.19: Change of orientation cores
Length:Width

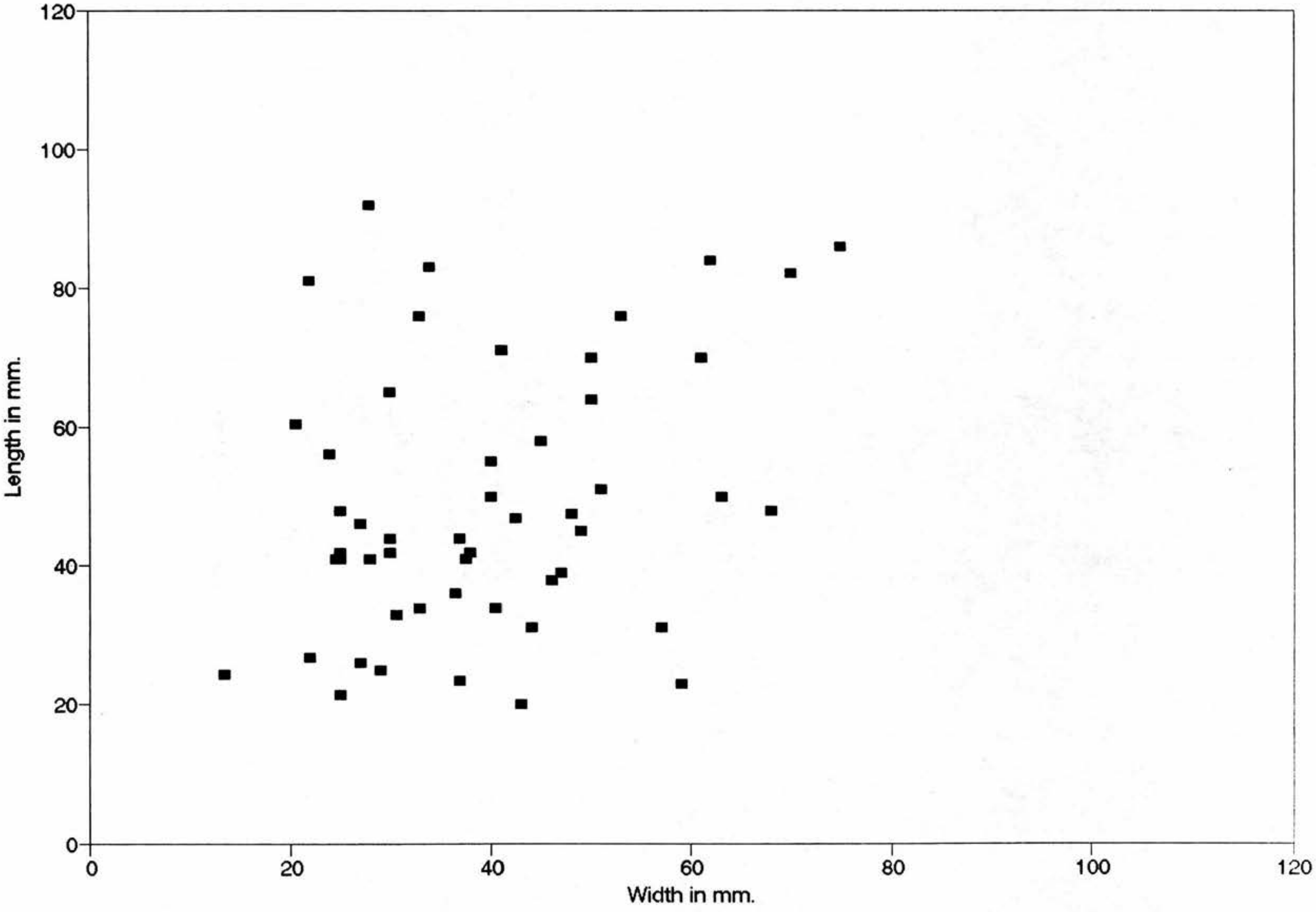
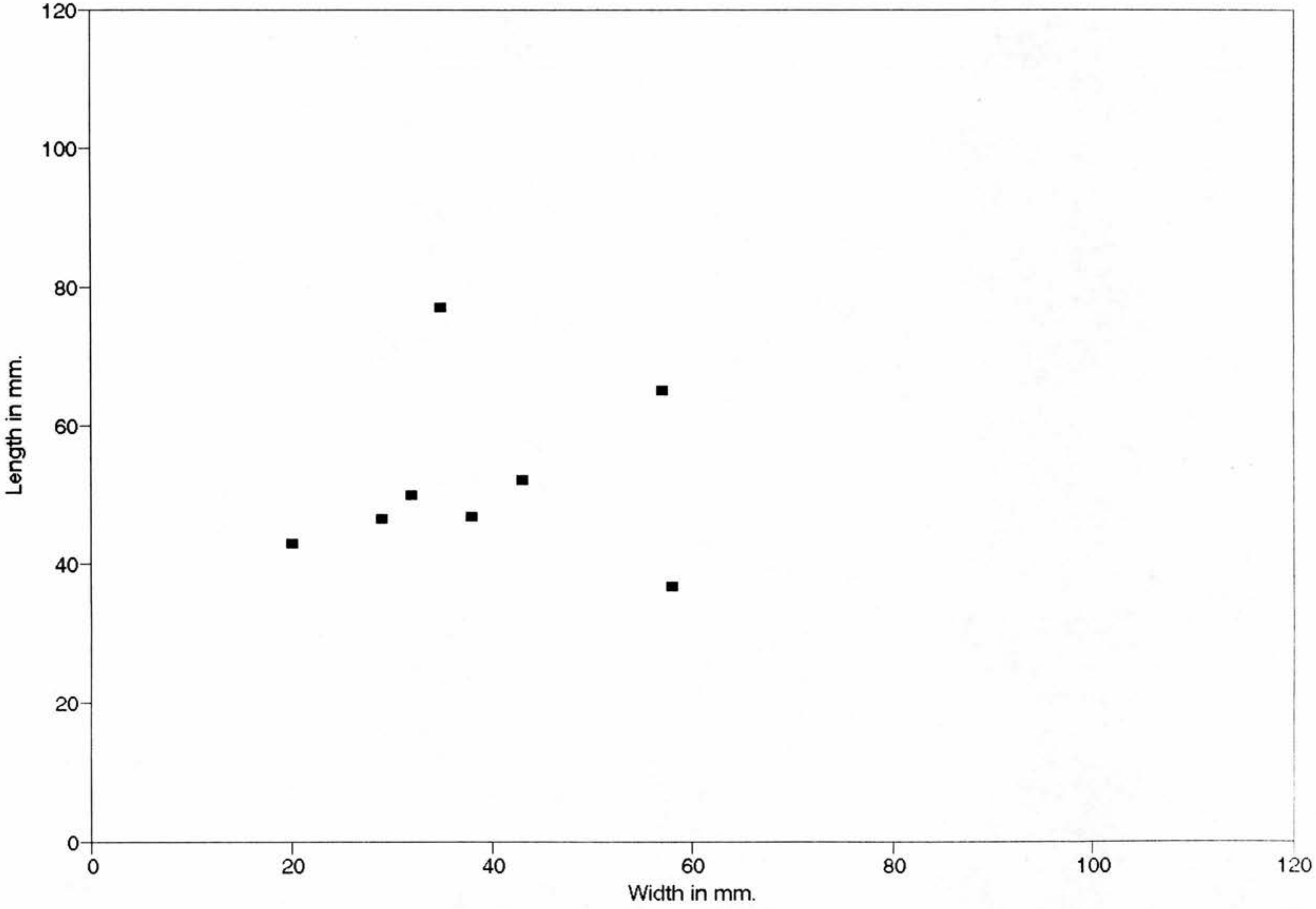


Fig 6.20: 90 Opposed platform cores
Length:Width



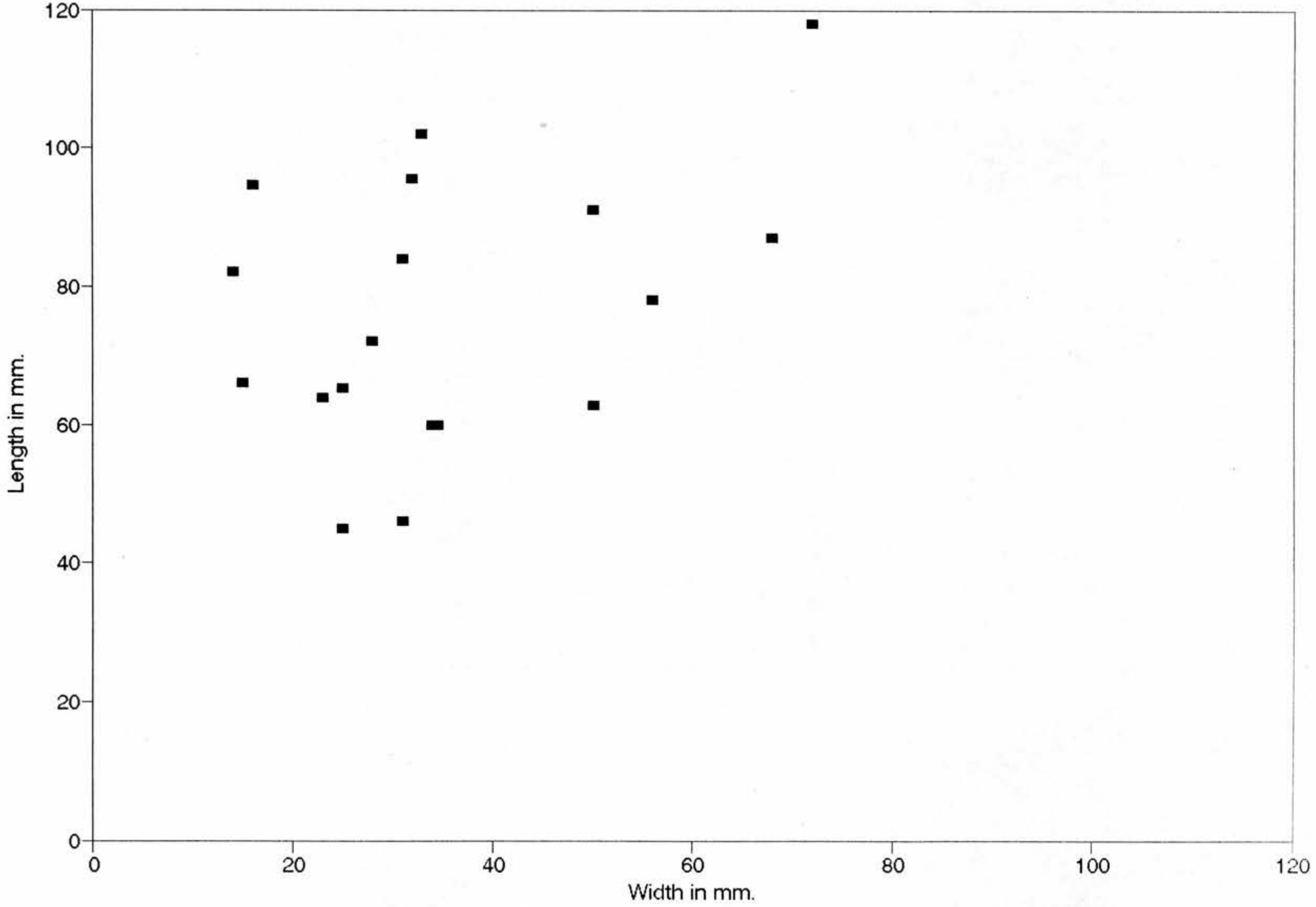


Fig 6.21: Alternate platform cores
Length:Width

Fig 6.22: Opposed platform cores, platform angles frequency

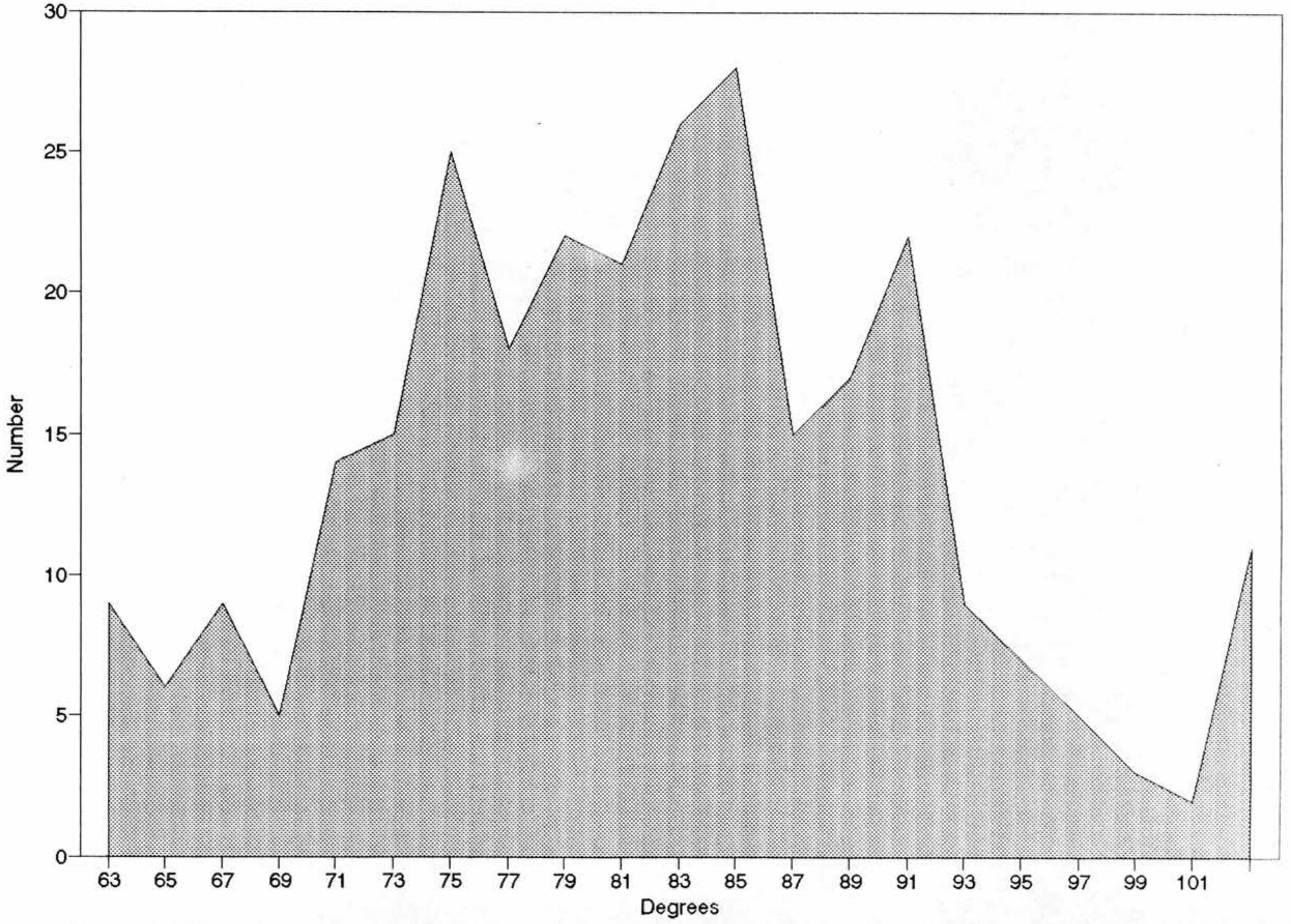


Fig 6.23: Change of orientation & transverse cores, platform angles freq.

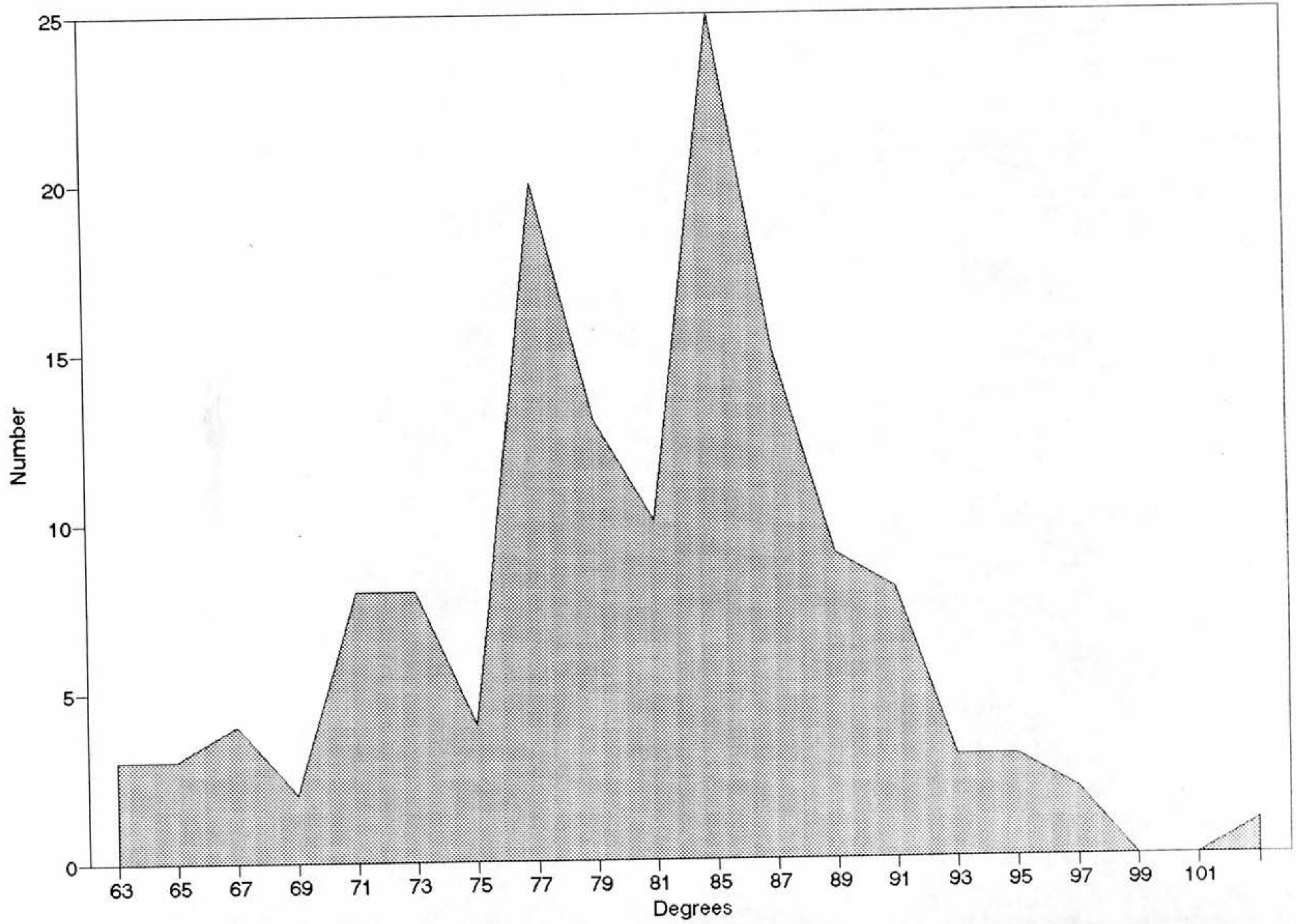


Fig 6.24: Discoidal cores, platform angles frequency

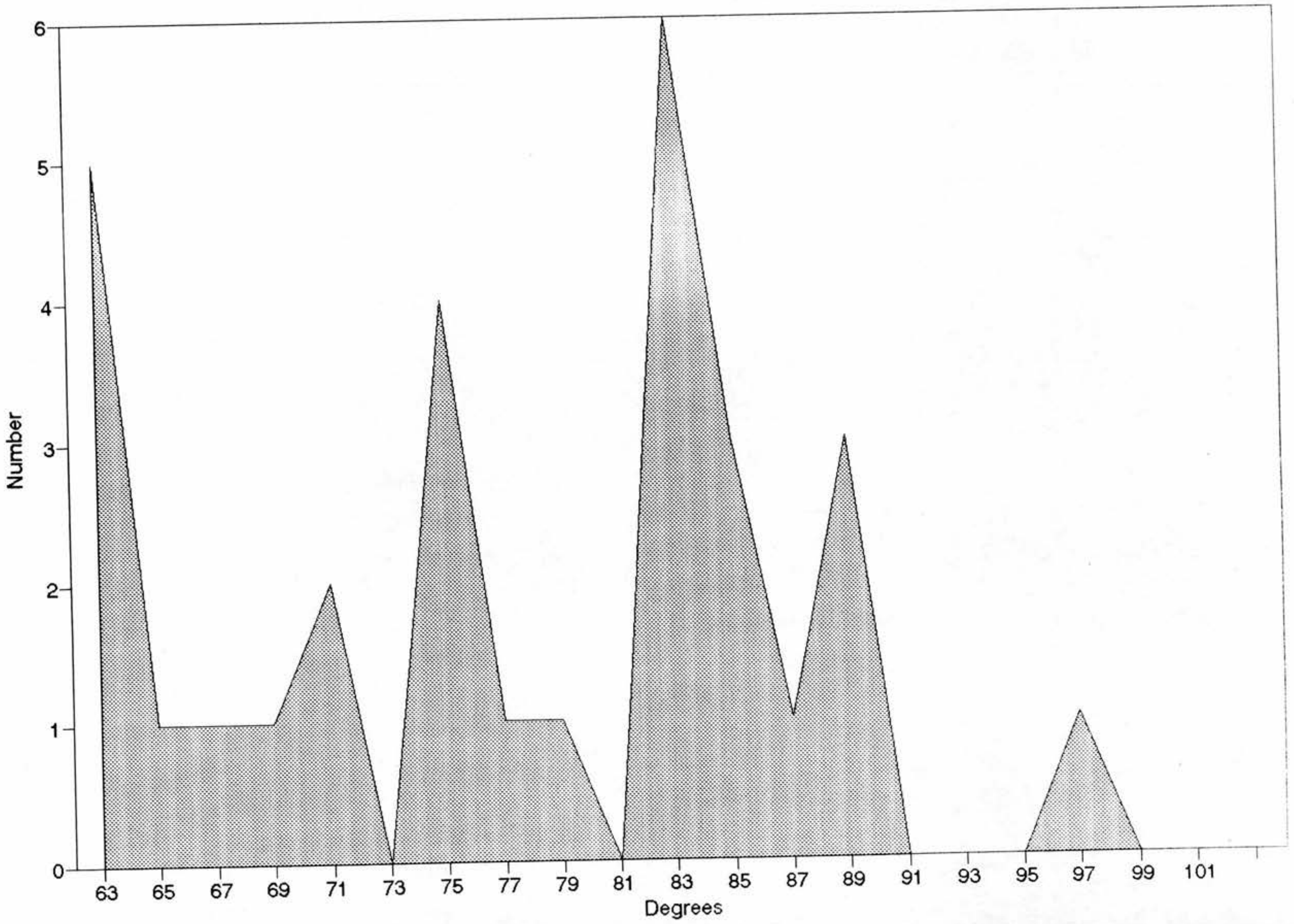


Fig 6.25: Preforms, platform angles frequency

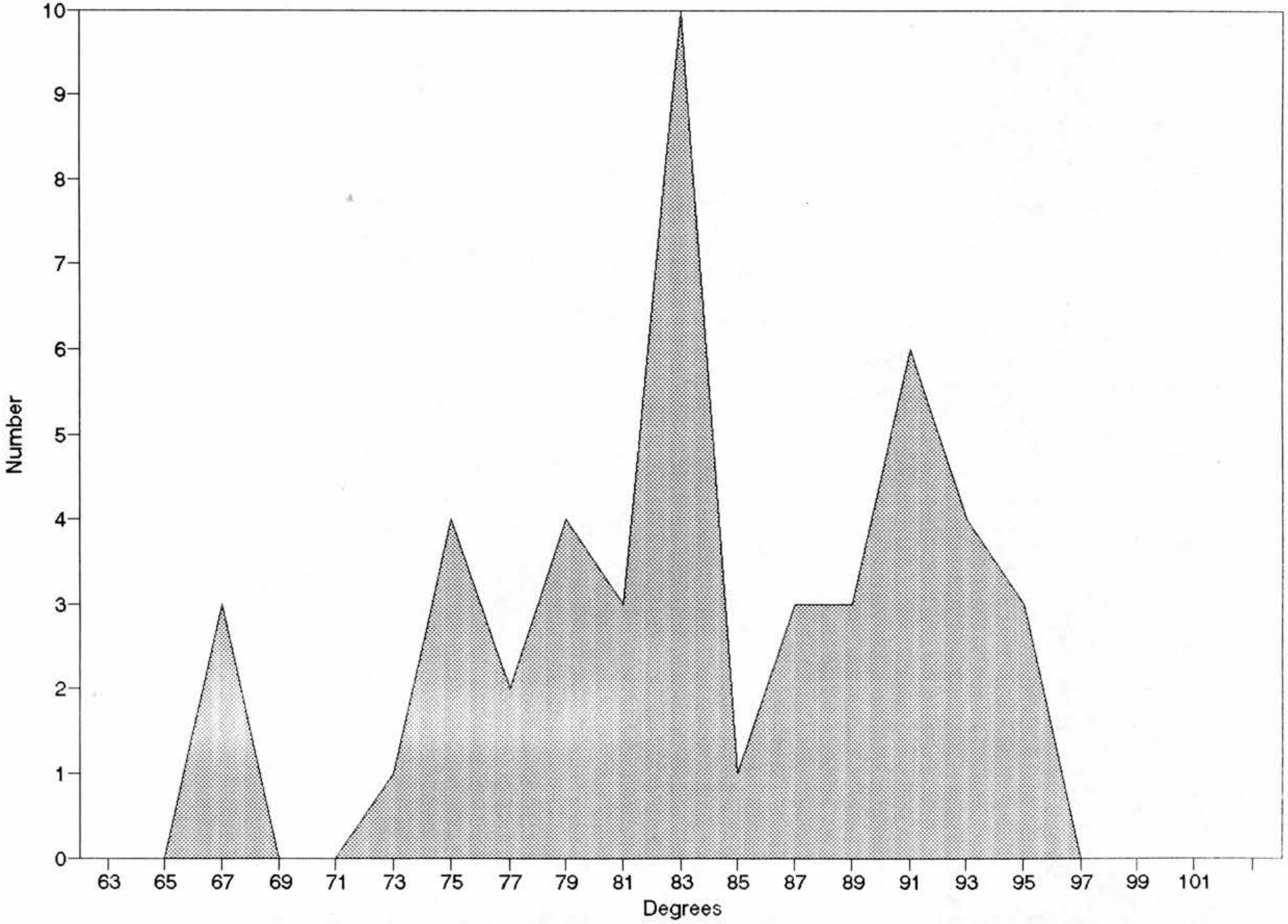


Fig 6.26: Alternate cores, platform angles frequency

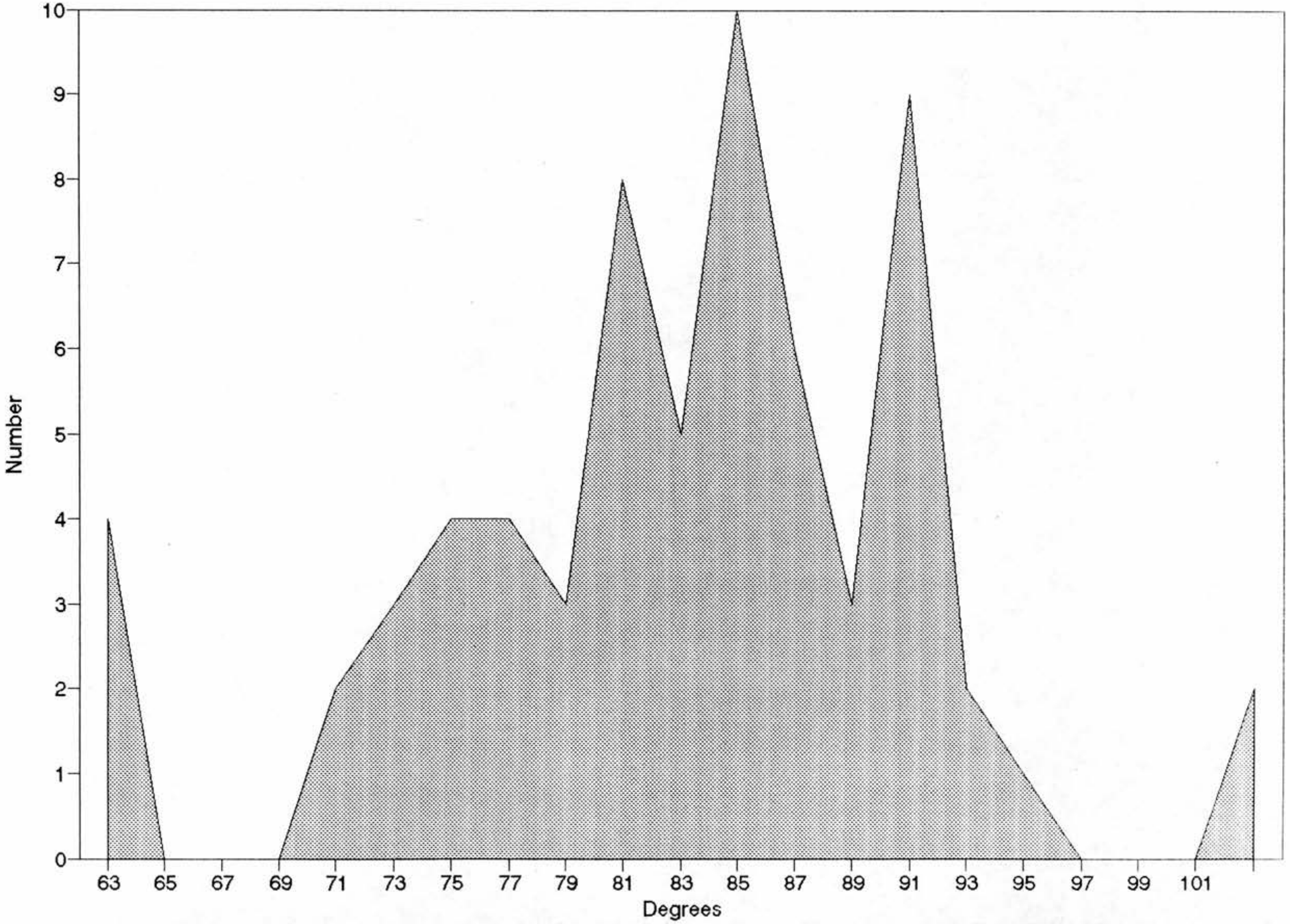


Fig 6.27: 90 opposed platform cores, platform angles frequency

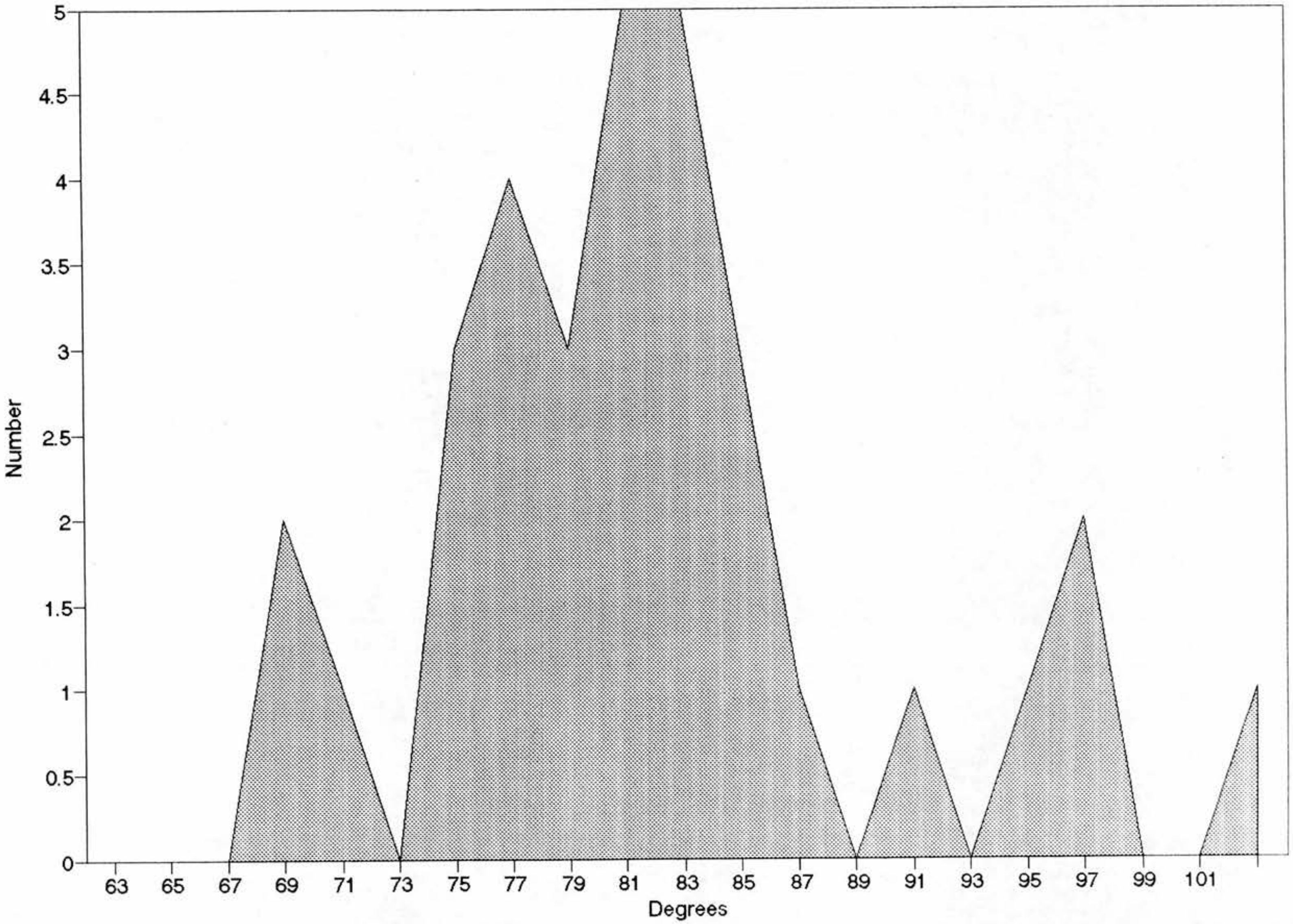


Fig 6.28: Single platform cores, platform angles frequency

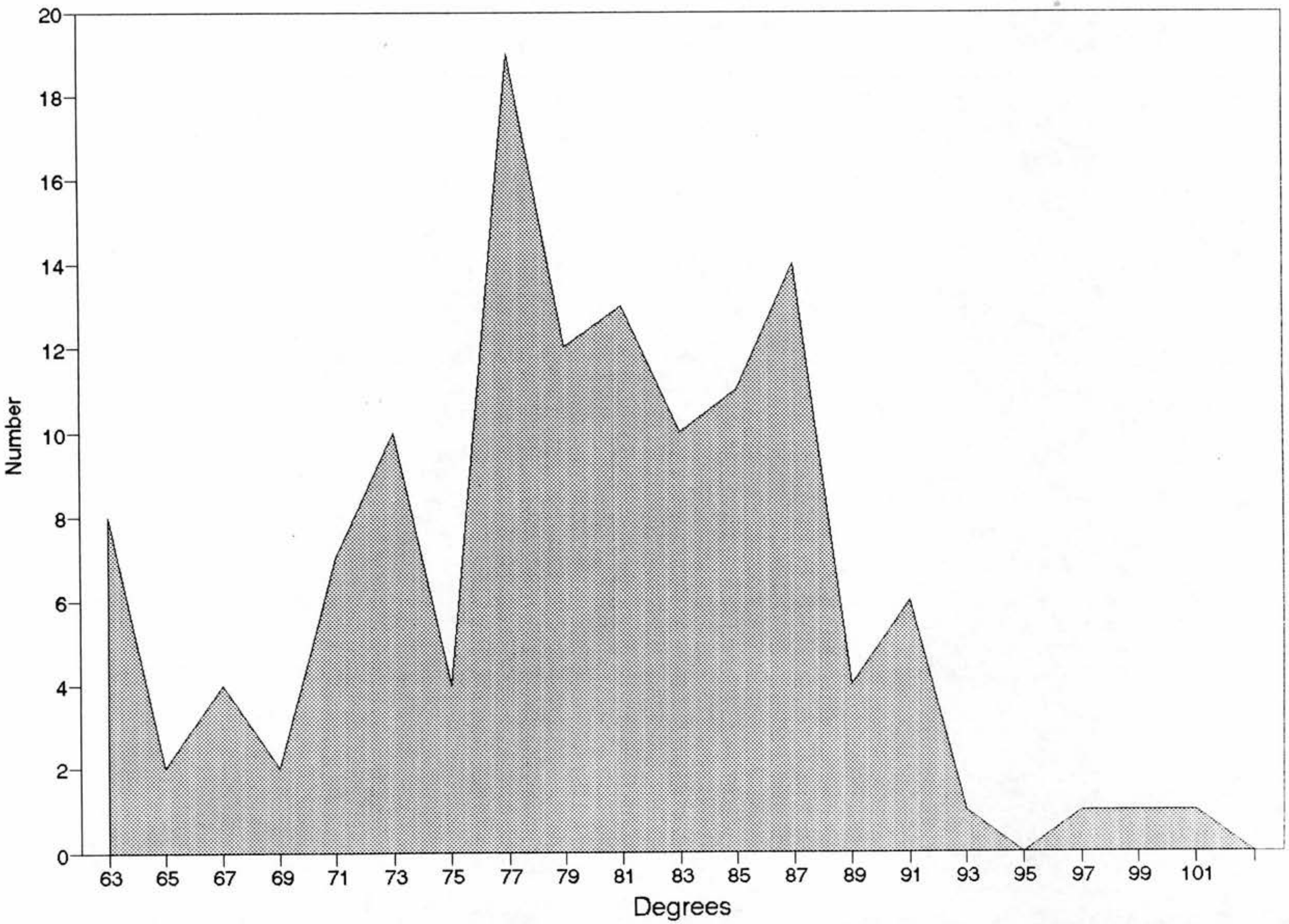


Fig 6.29: Opposed platform cores, % of cortex, freqency of occurrences

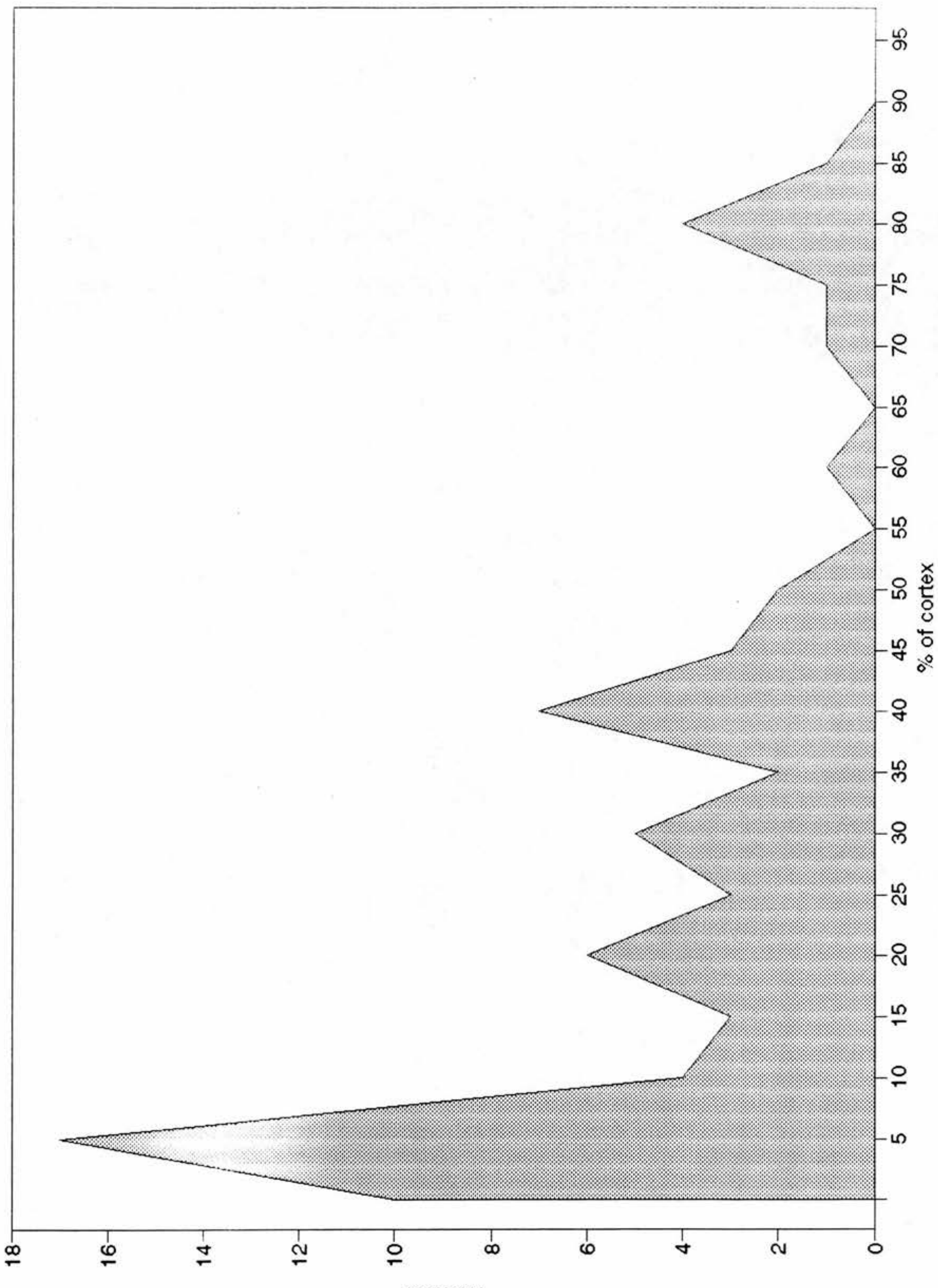


Fig 6.30: Single platform cores,
% of cortex, frequency of occurrences

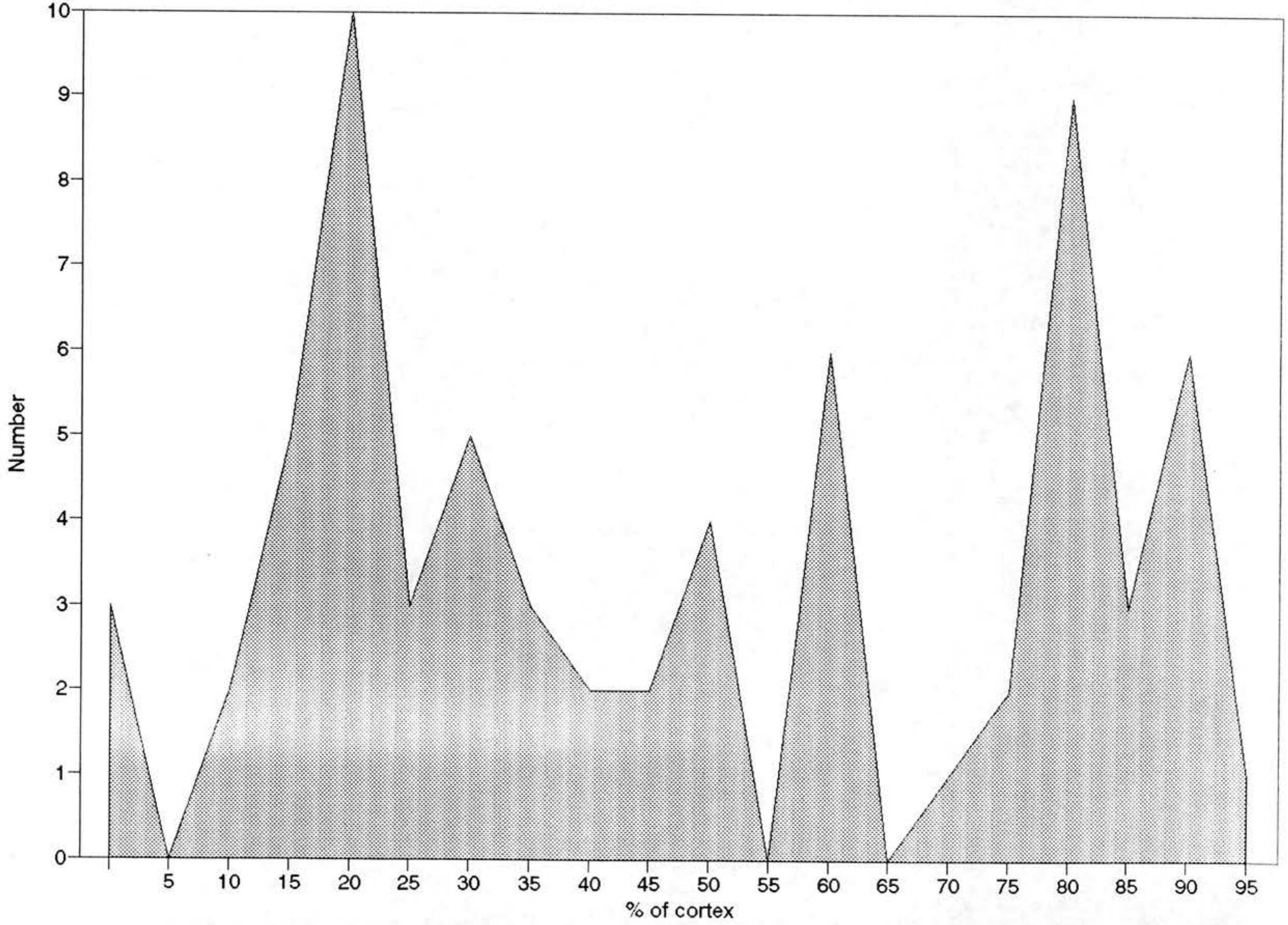


Fig 6.31: Wadi raw material cores,
% of cortex, frequency of occurrences

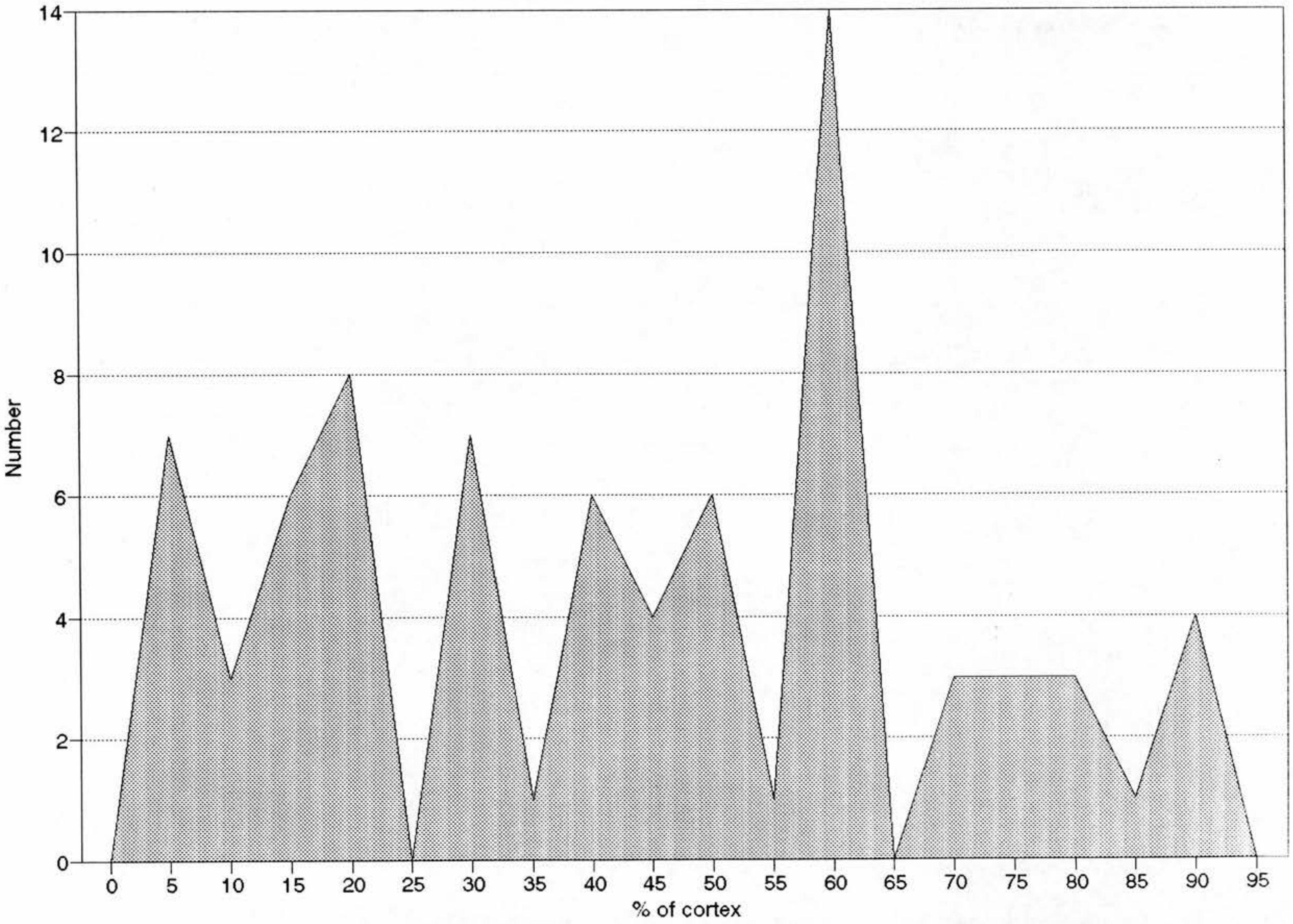


Fig 6.32: Tabular raw material cores, % of cortex, frequency of occurrences

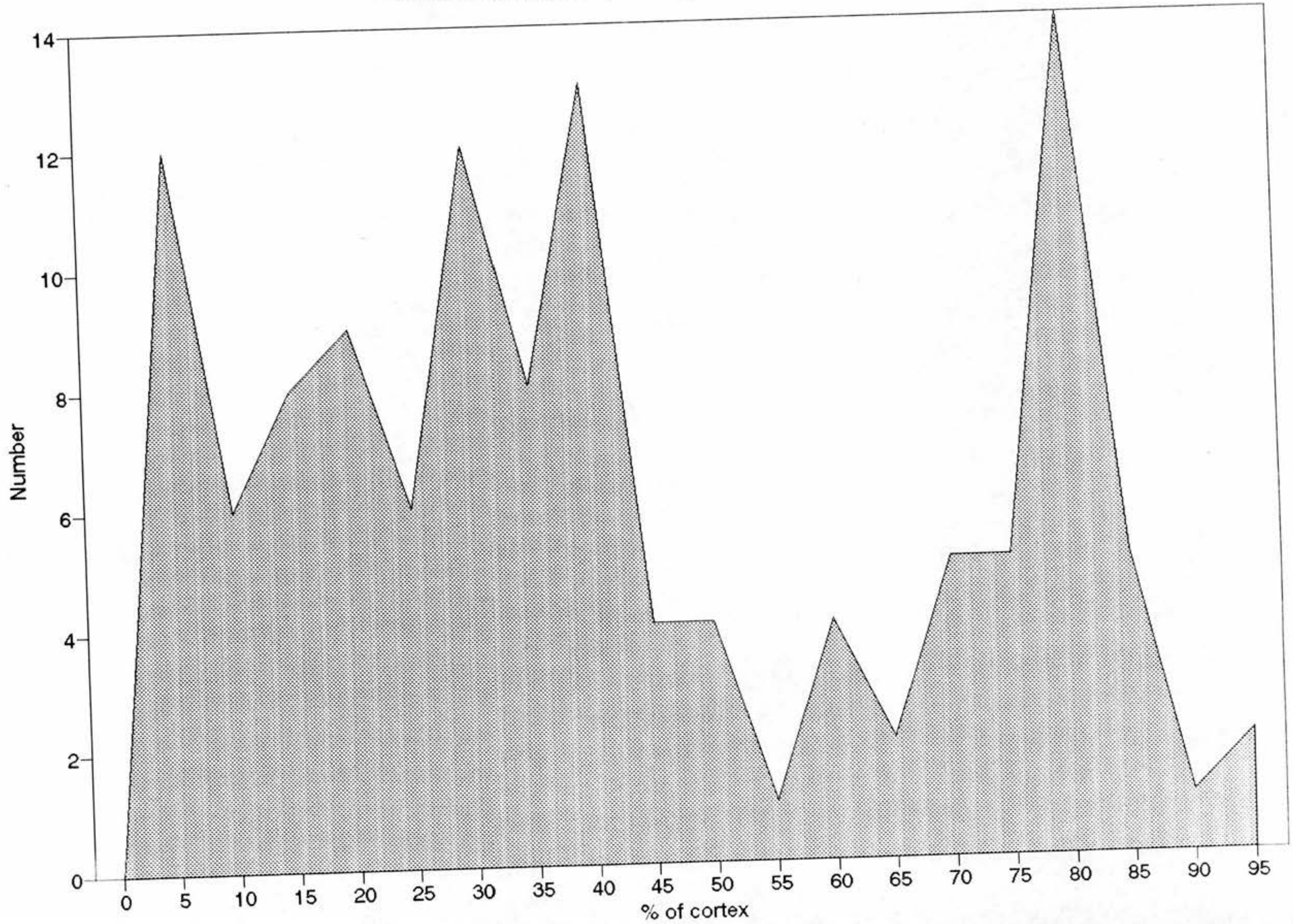


Fig 6.33: Naviform cores sensu stricto
Length:Width

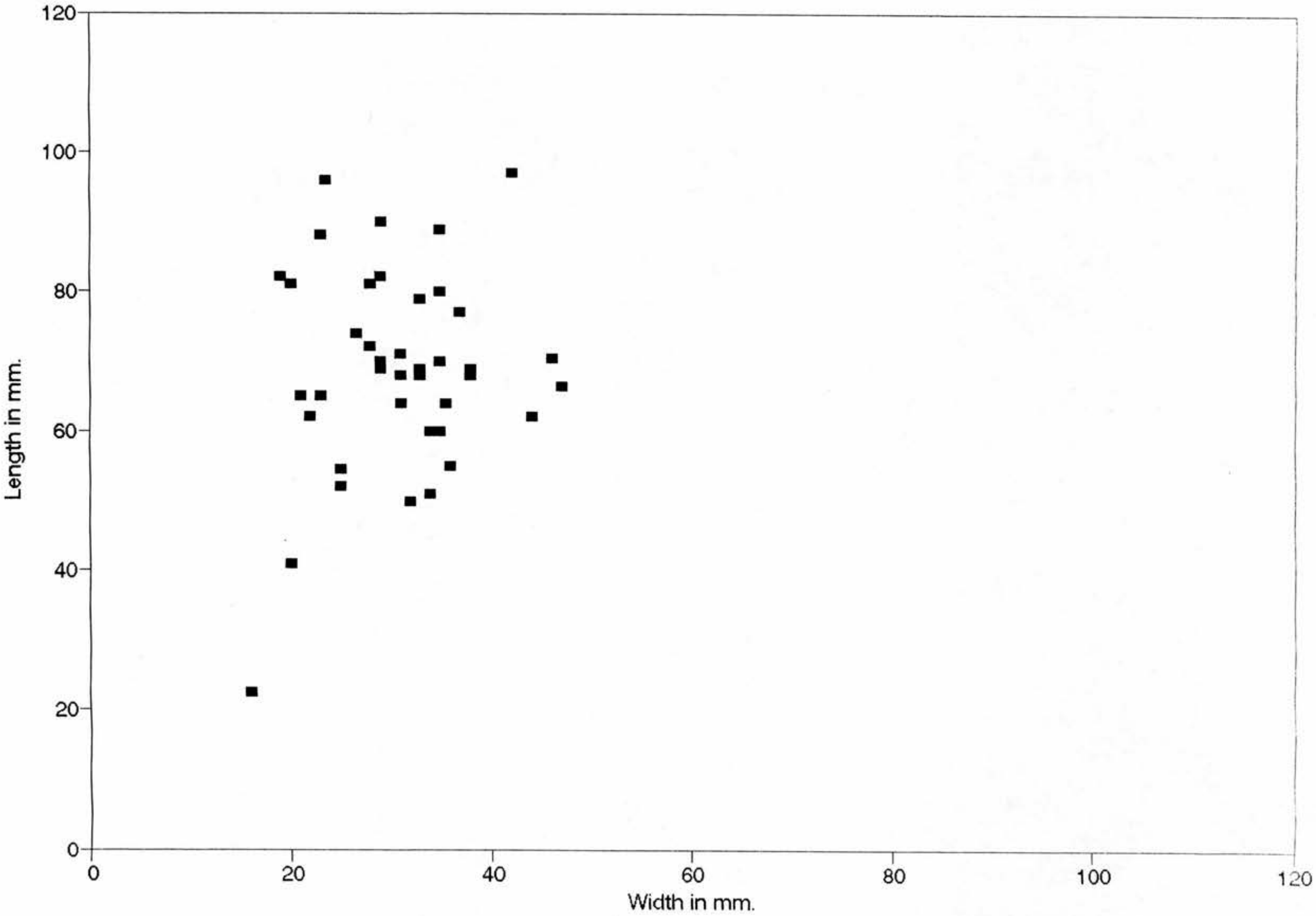


Fig 6.34: Naviform-tabular cores
Length:Width

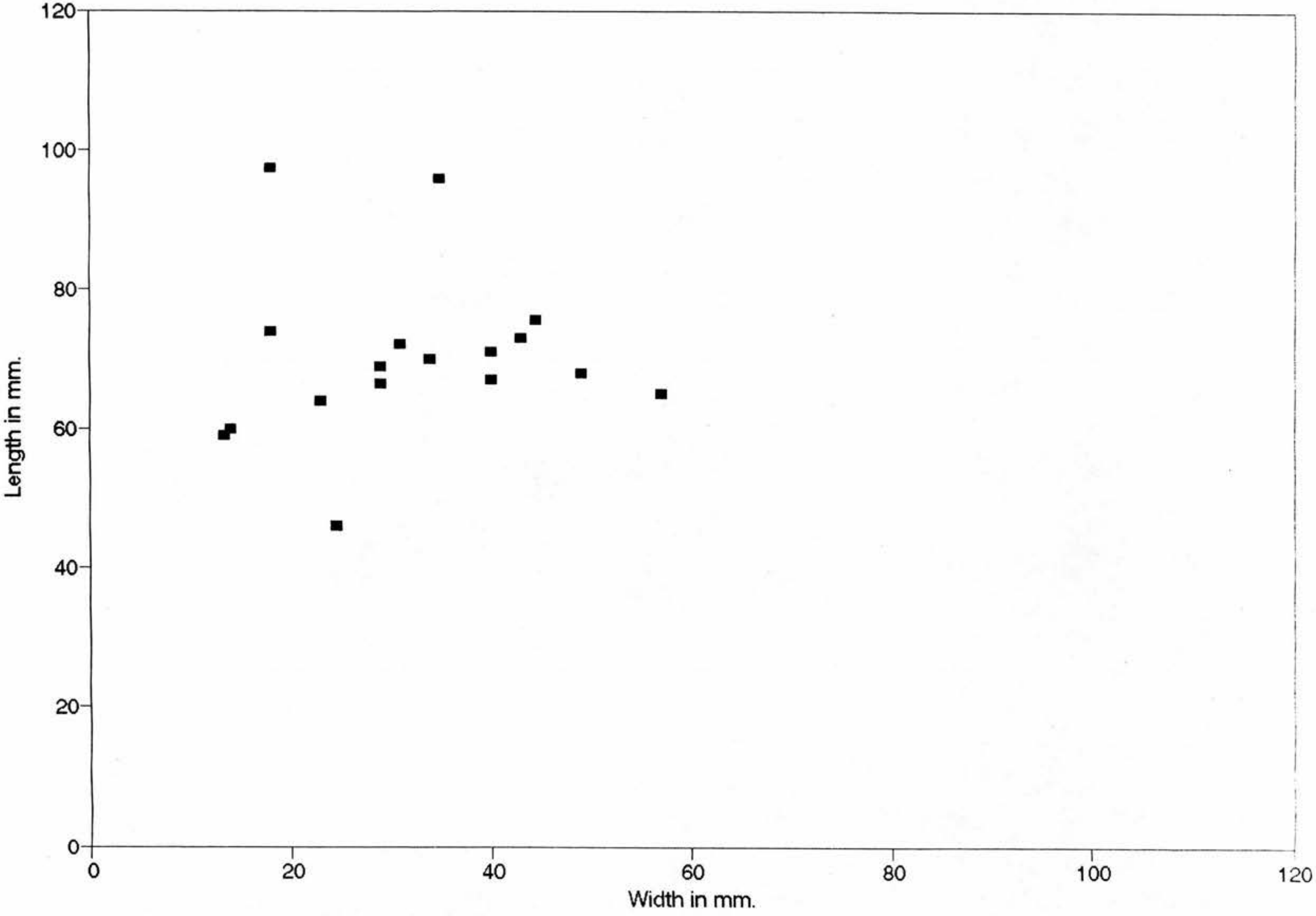


Fig 6.35: Sub-naviform cores
Length:Width

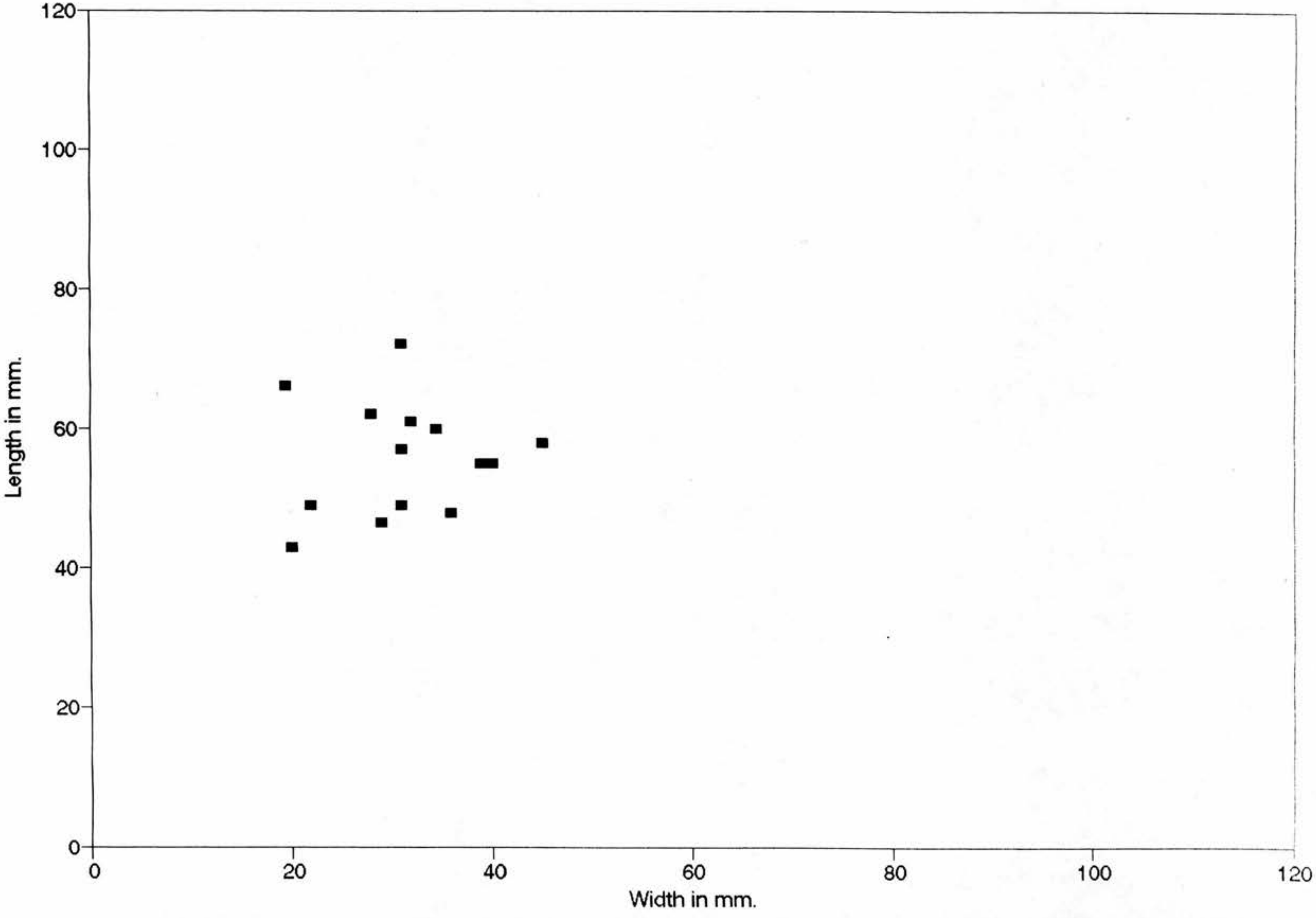


Fig 6.36: Sub-naviform-tabular cores
Length:Width

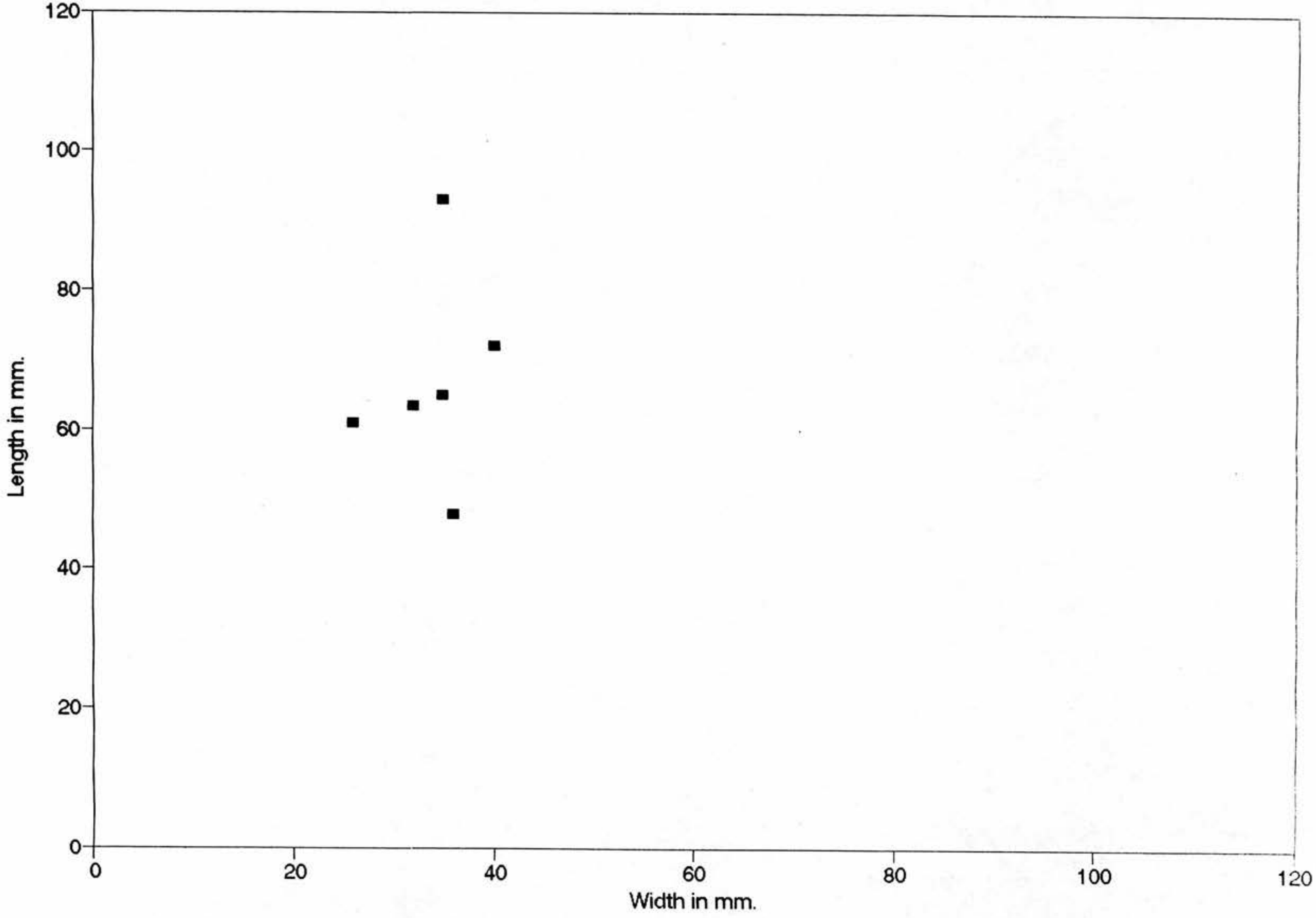


Fig 6.37: Pyramidal cores
Length:Width

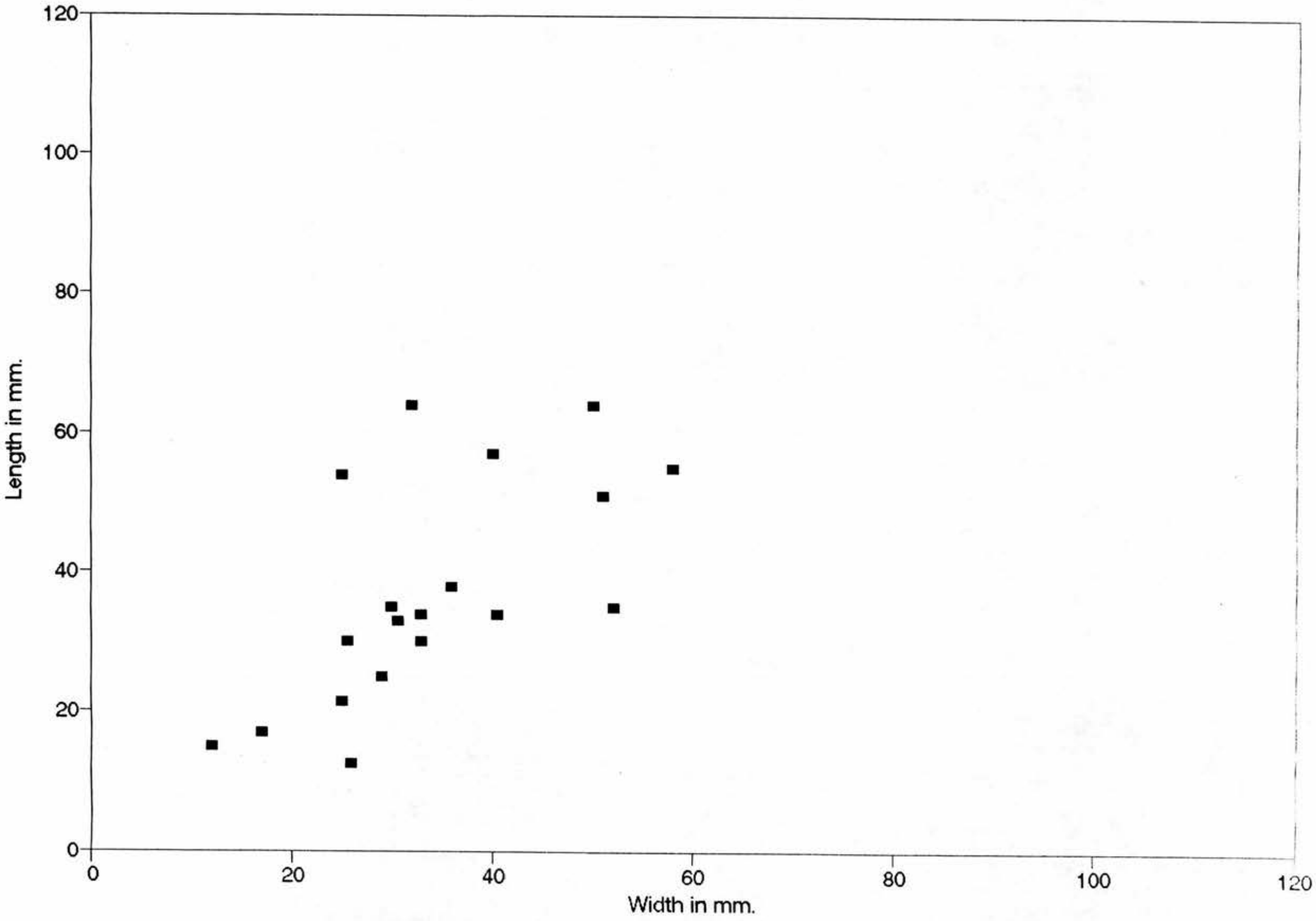


Fig 6.38: Flake cores
Length:Width

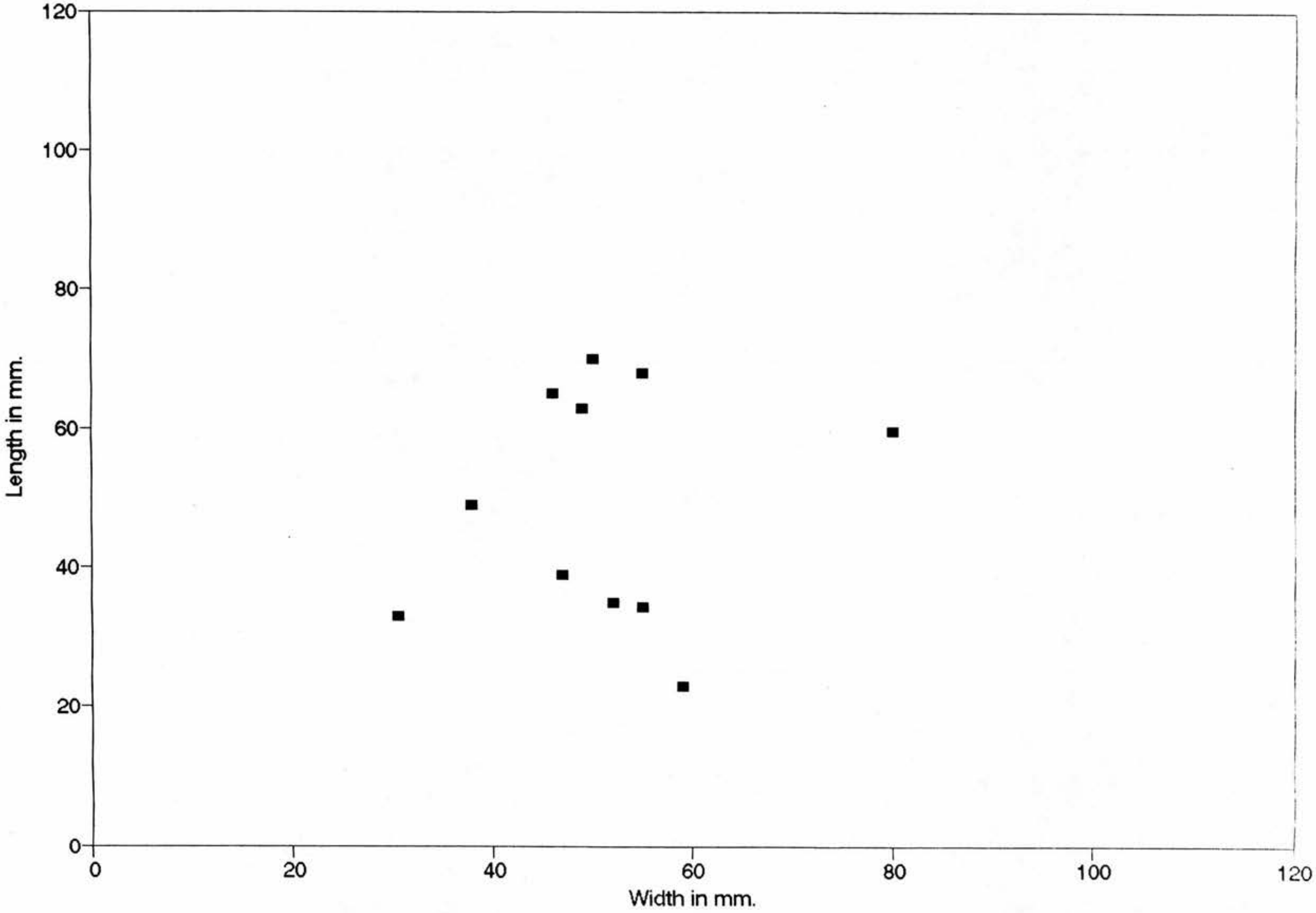


Fig 6.39: Irregular cores
Length:Width

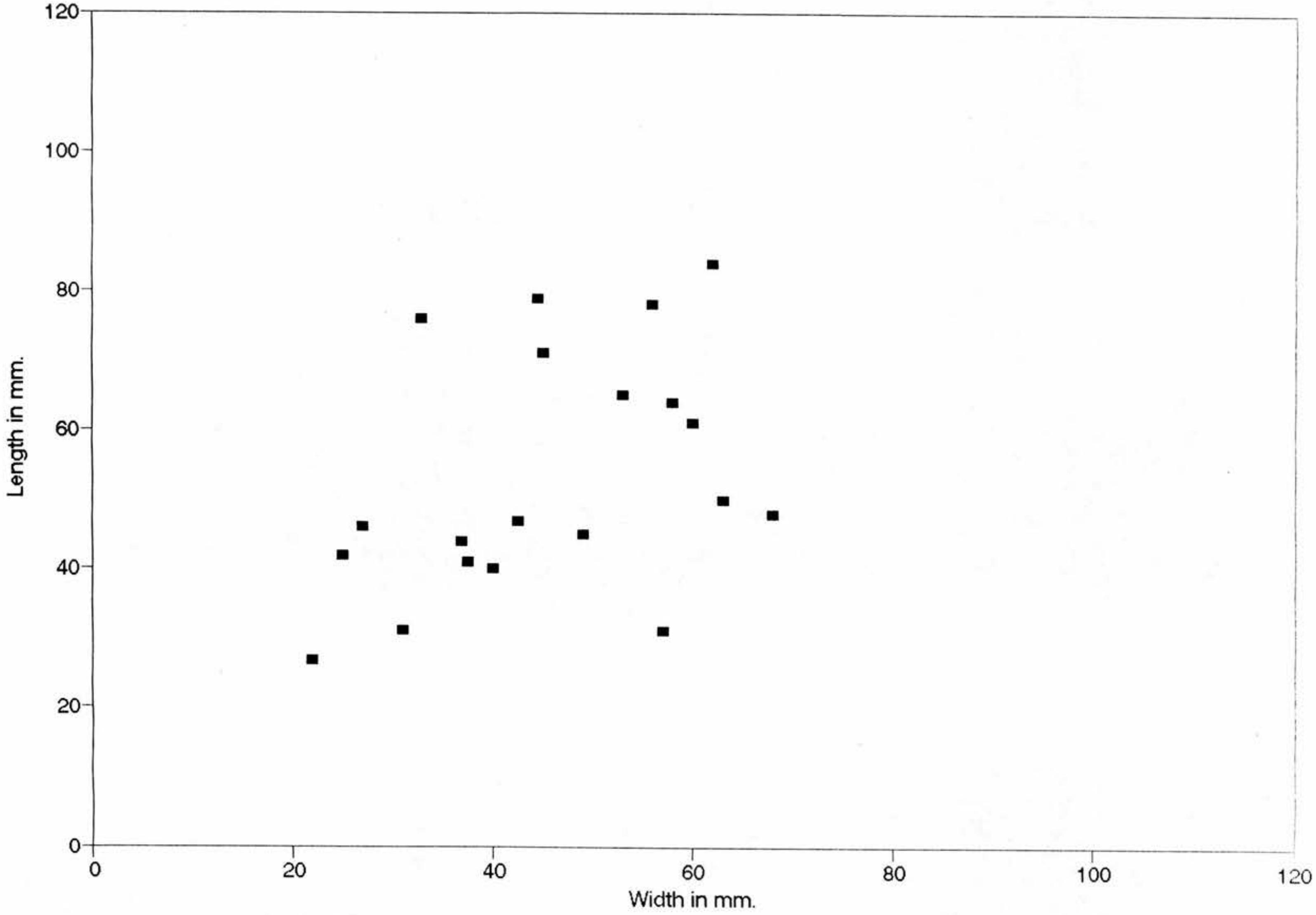


Fig 6.40: Cobble shaped cores
Length:Width

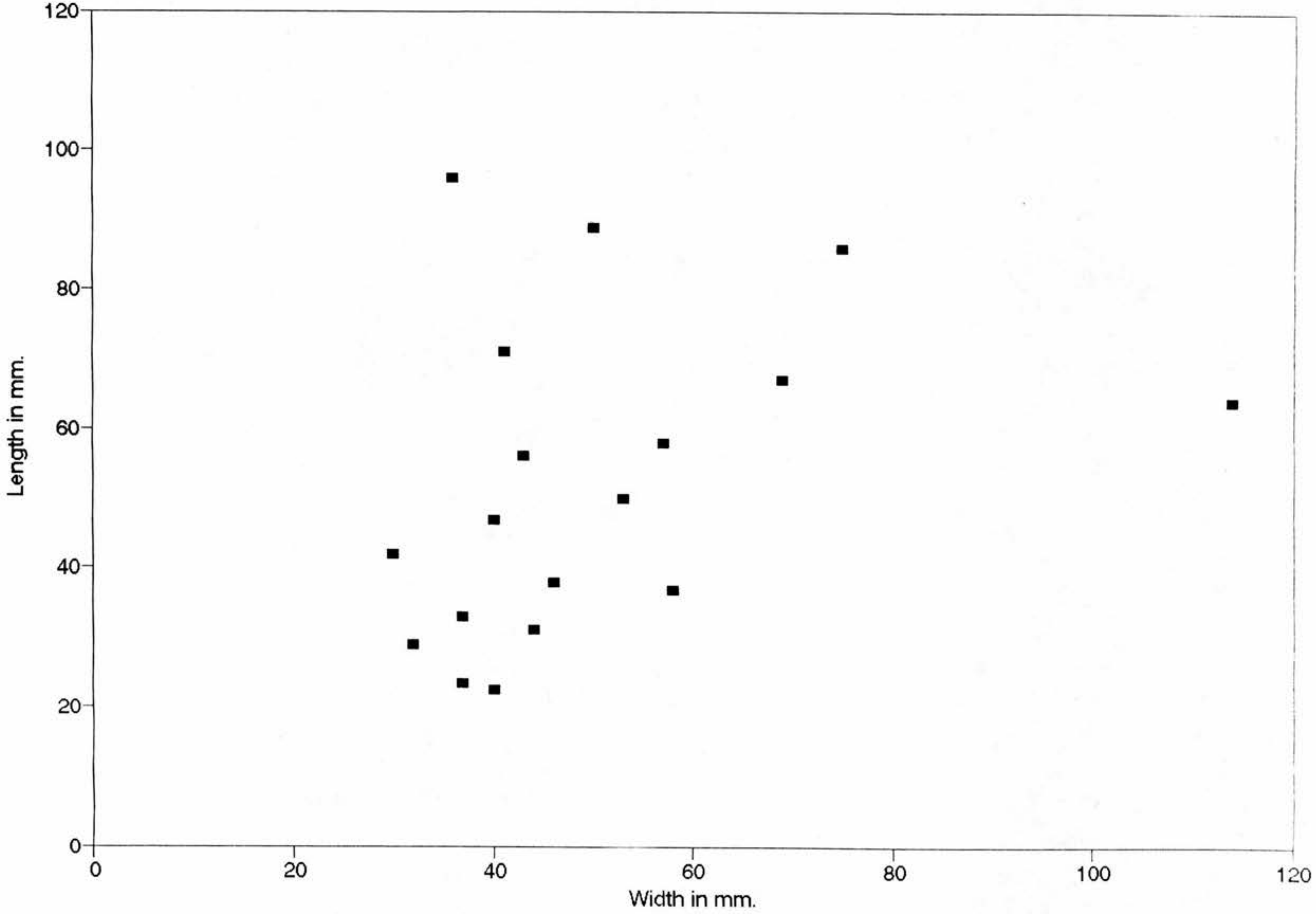


Fig 6.41: Prismatic cores
Length:Width

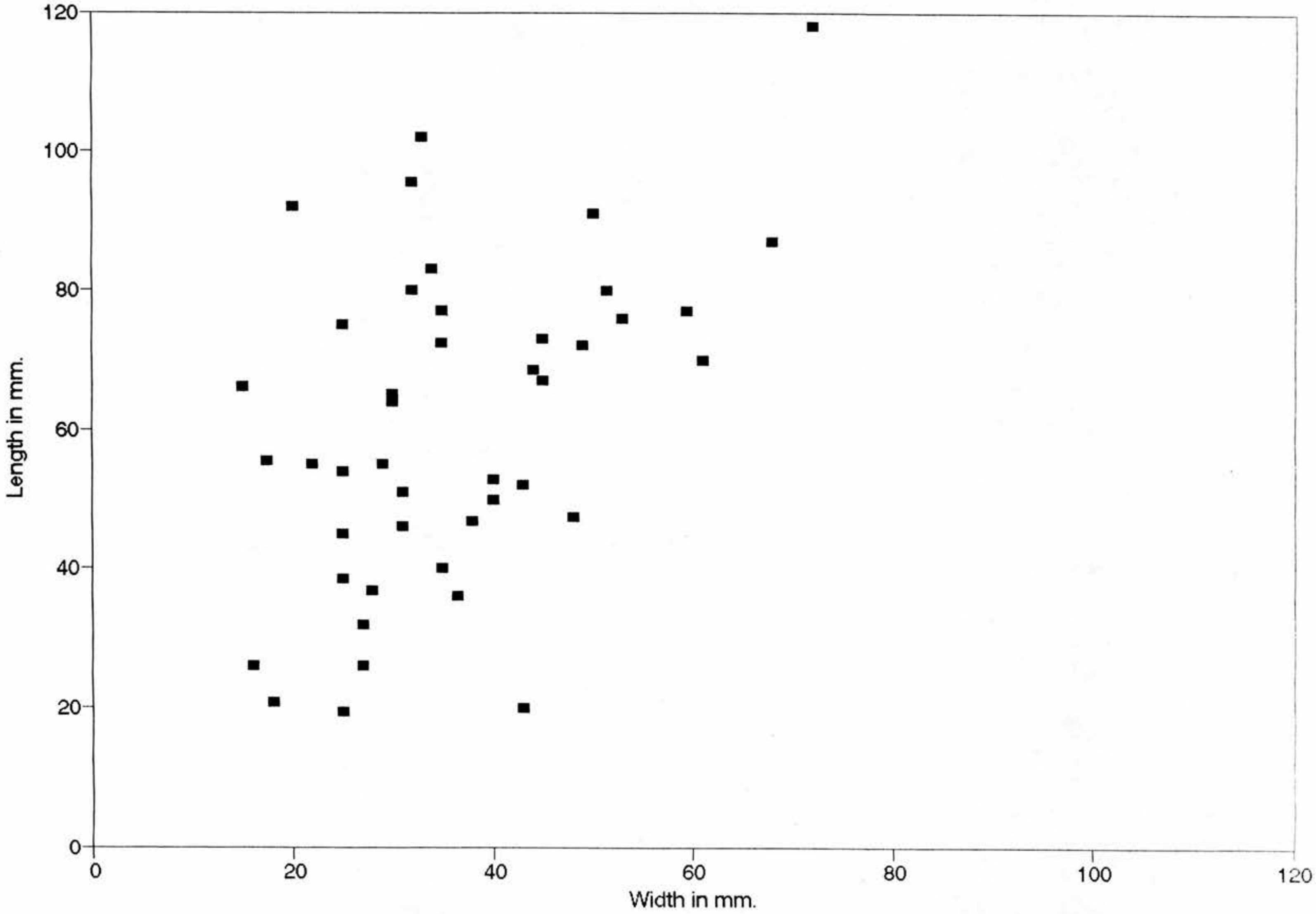


Fig 6.42: Tabular edge cores
Length:Width

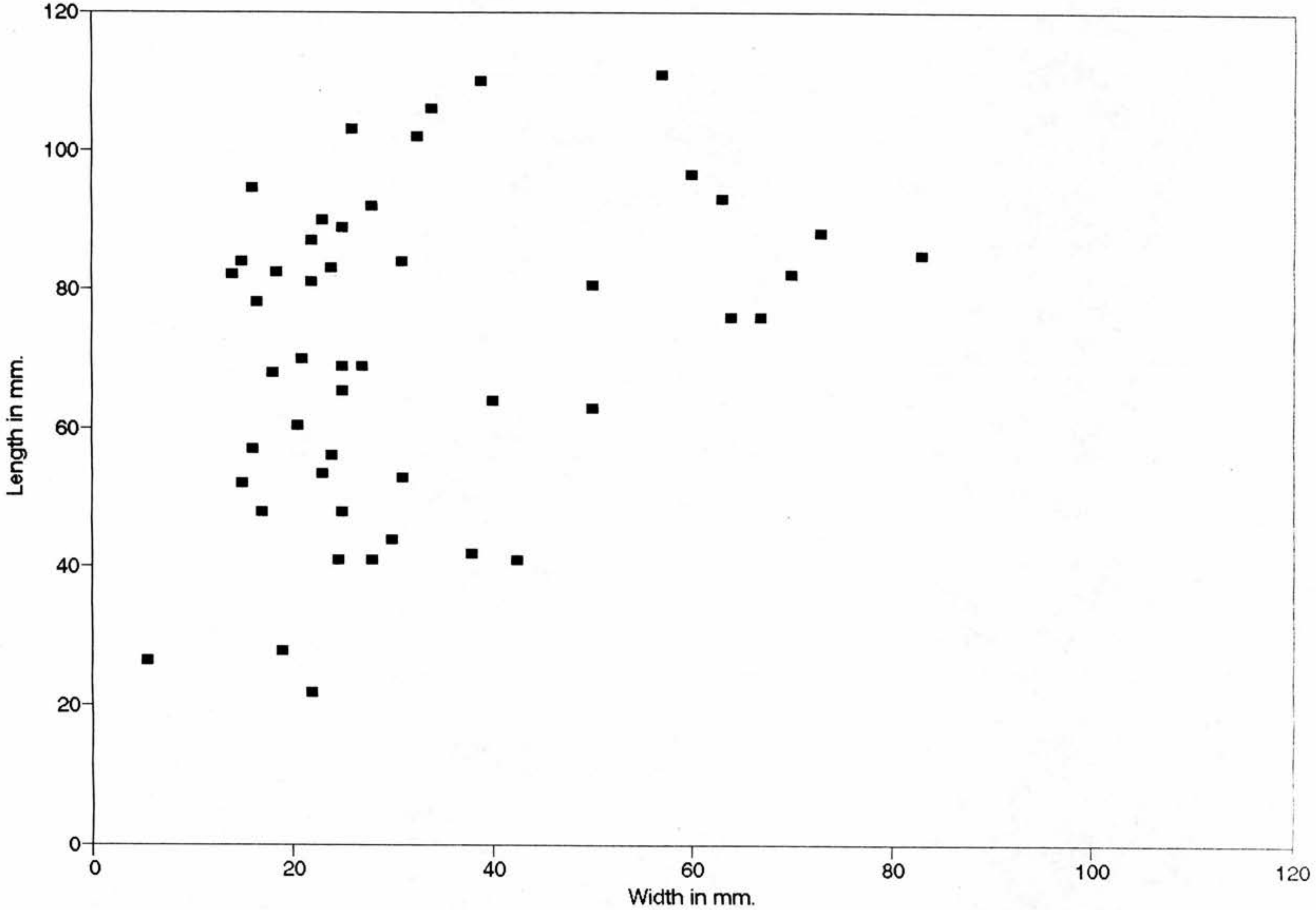


Fig 6:43: Bifacial shaped cores
Length:Width

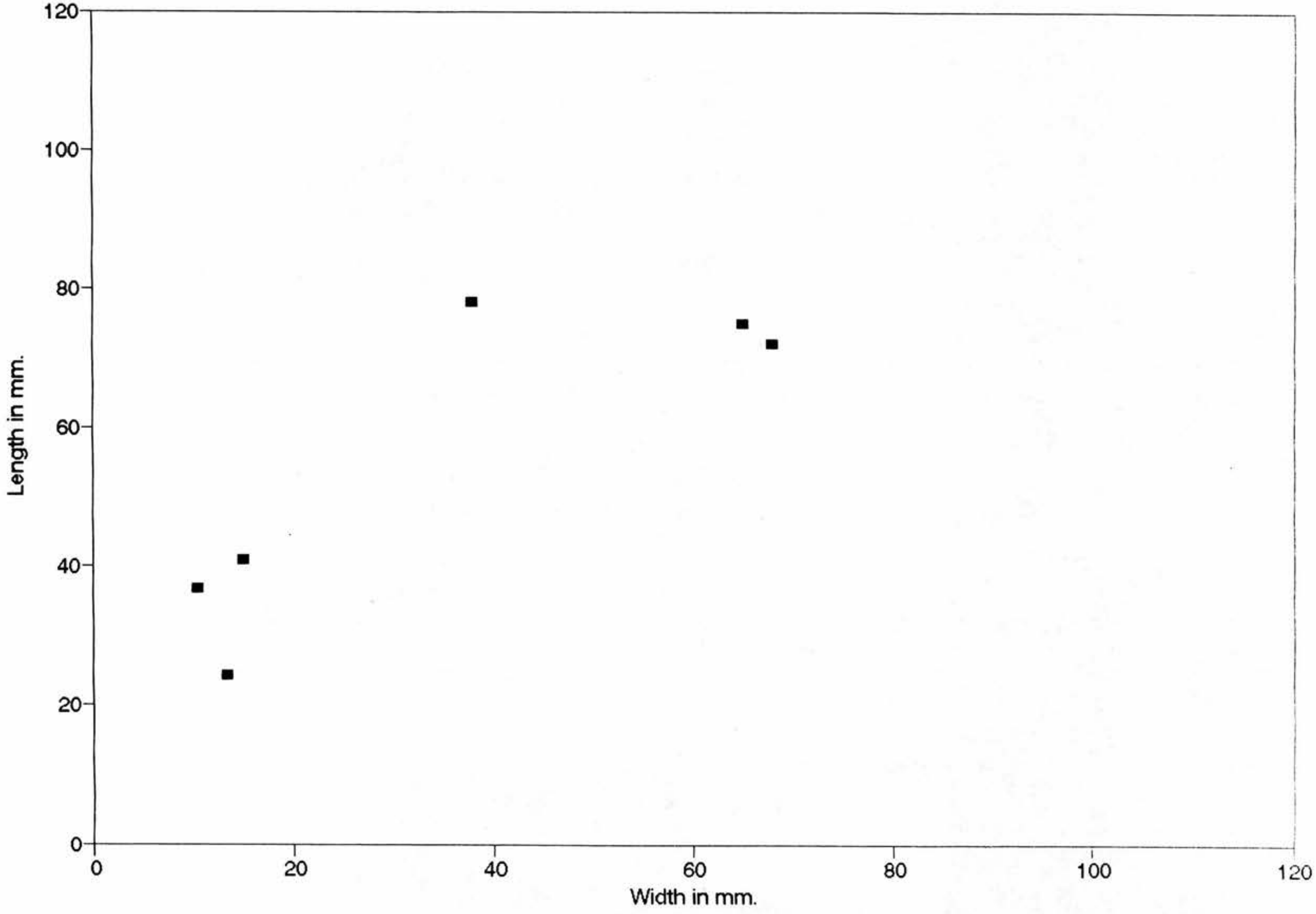


Fig. 6.44 Prismatic cores,
platform angles frequency

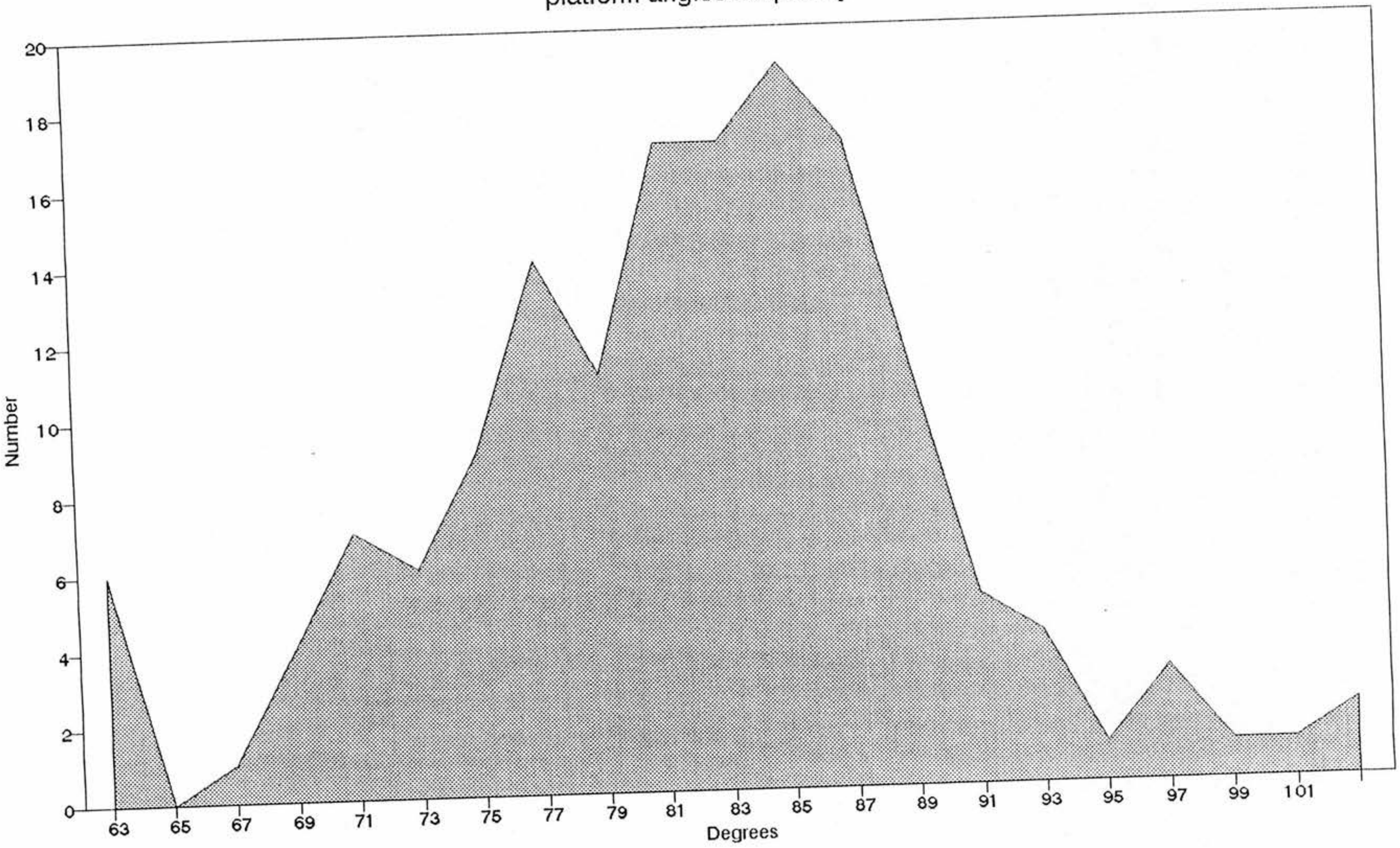
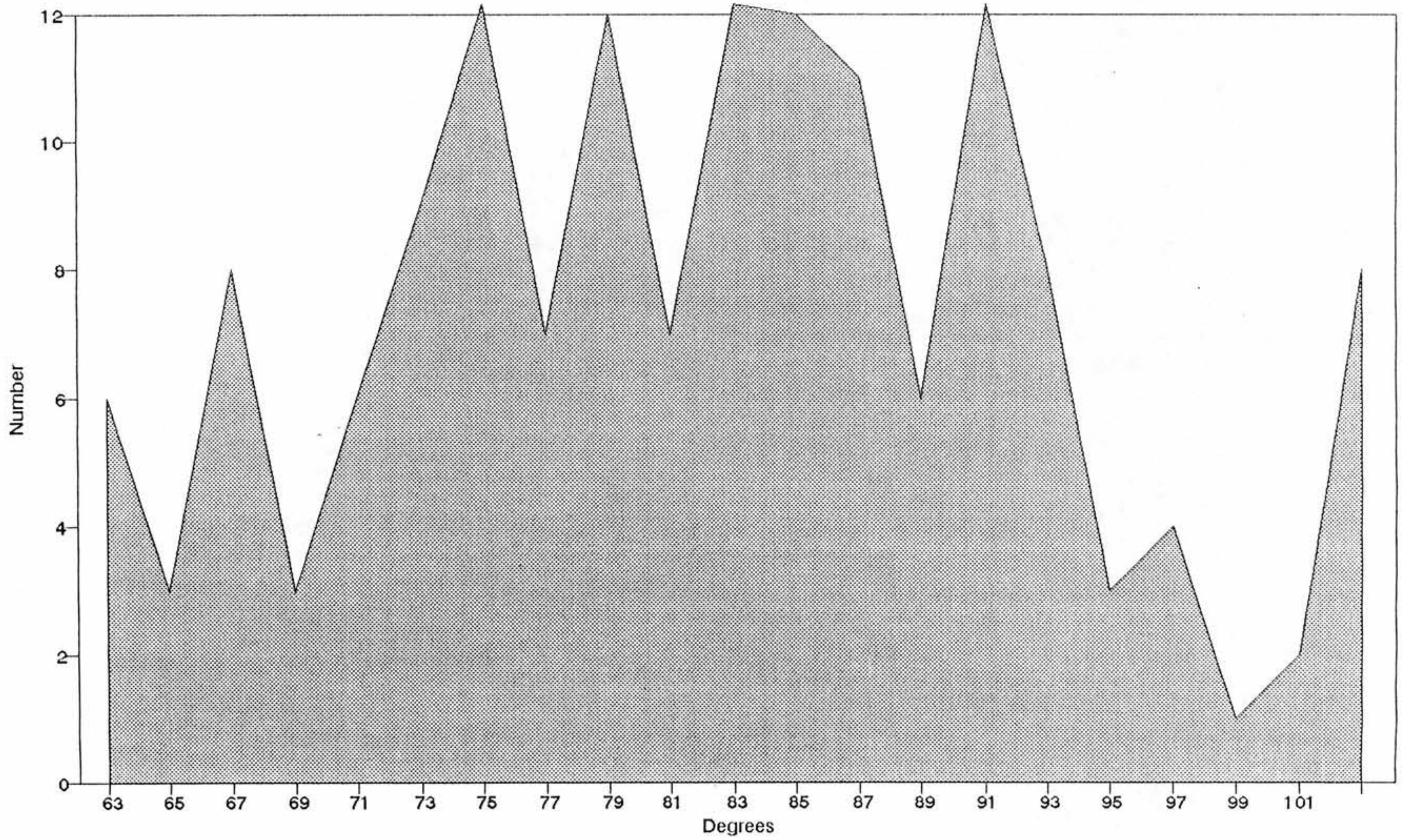


Fig. 6.45 Naviform cores, platform angles frequency



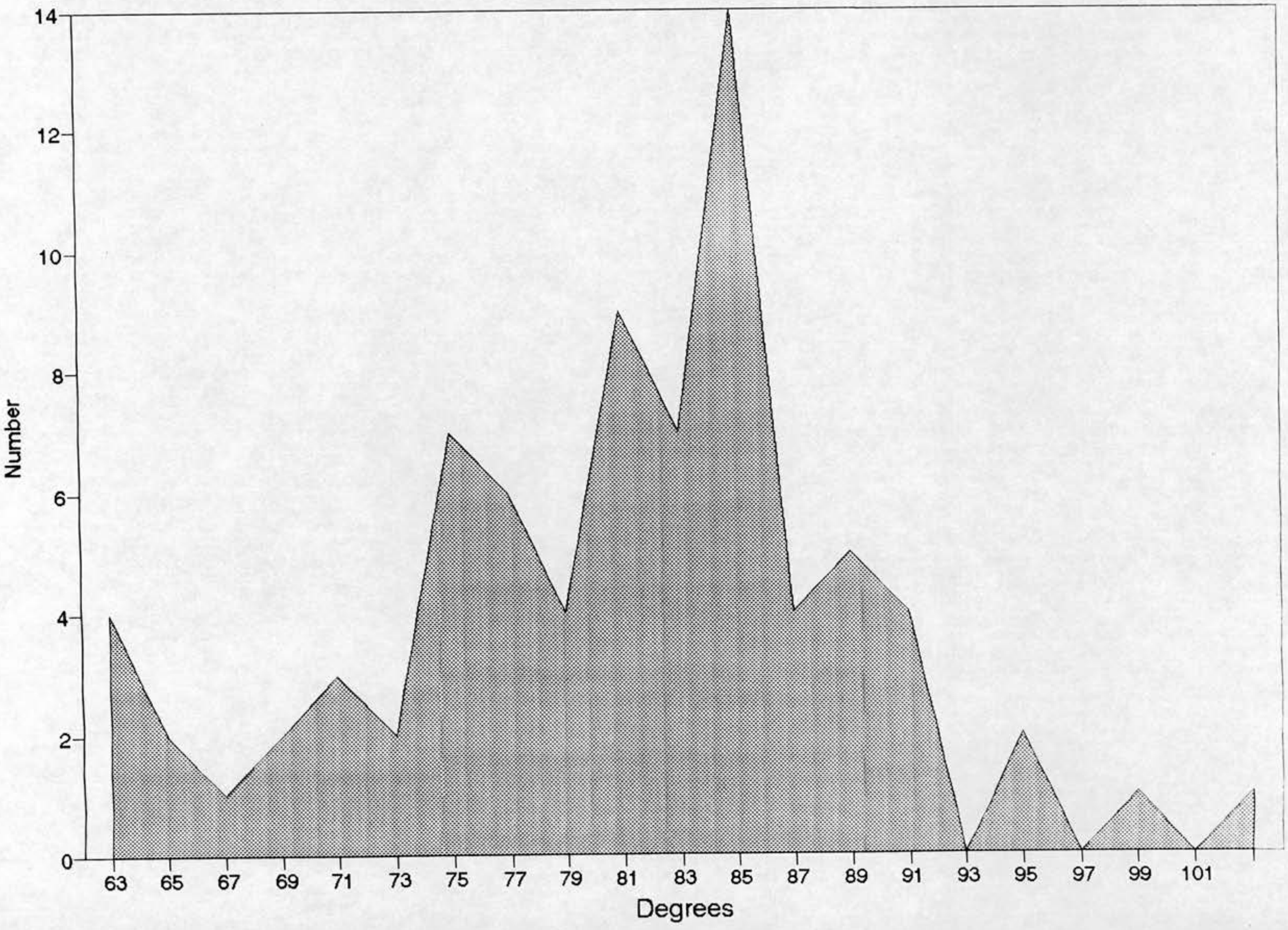


Fig 6.46: Sub-naviform cores, platform angles frequency

Fig. 6.47 Naviform-tabular cores, platform angles frequency

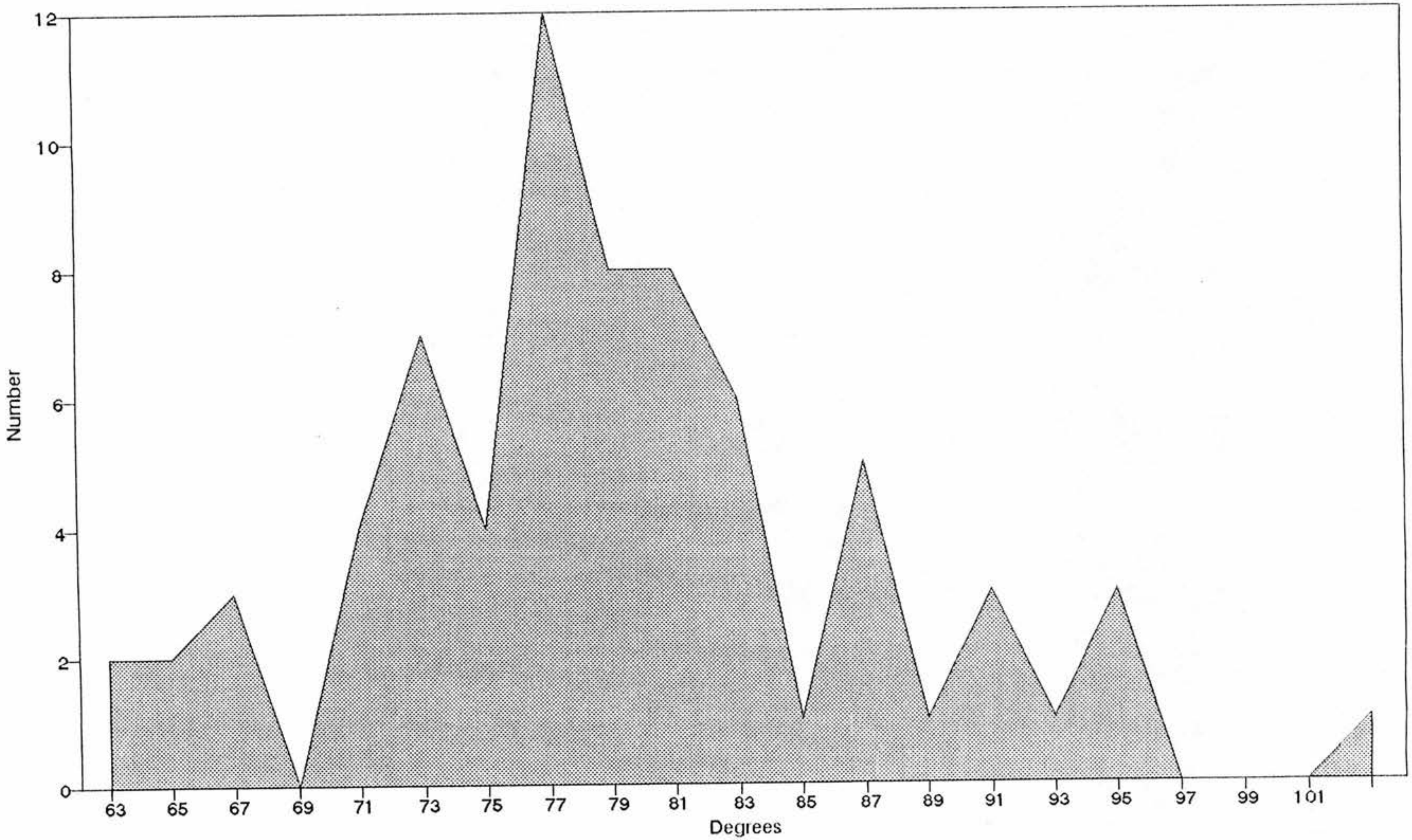


Fig 6.48: Tabular edge cores, platform angles frequency

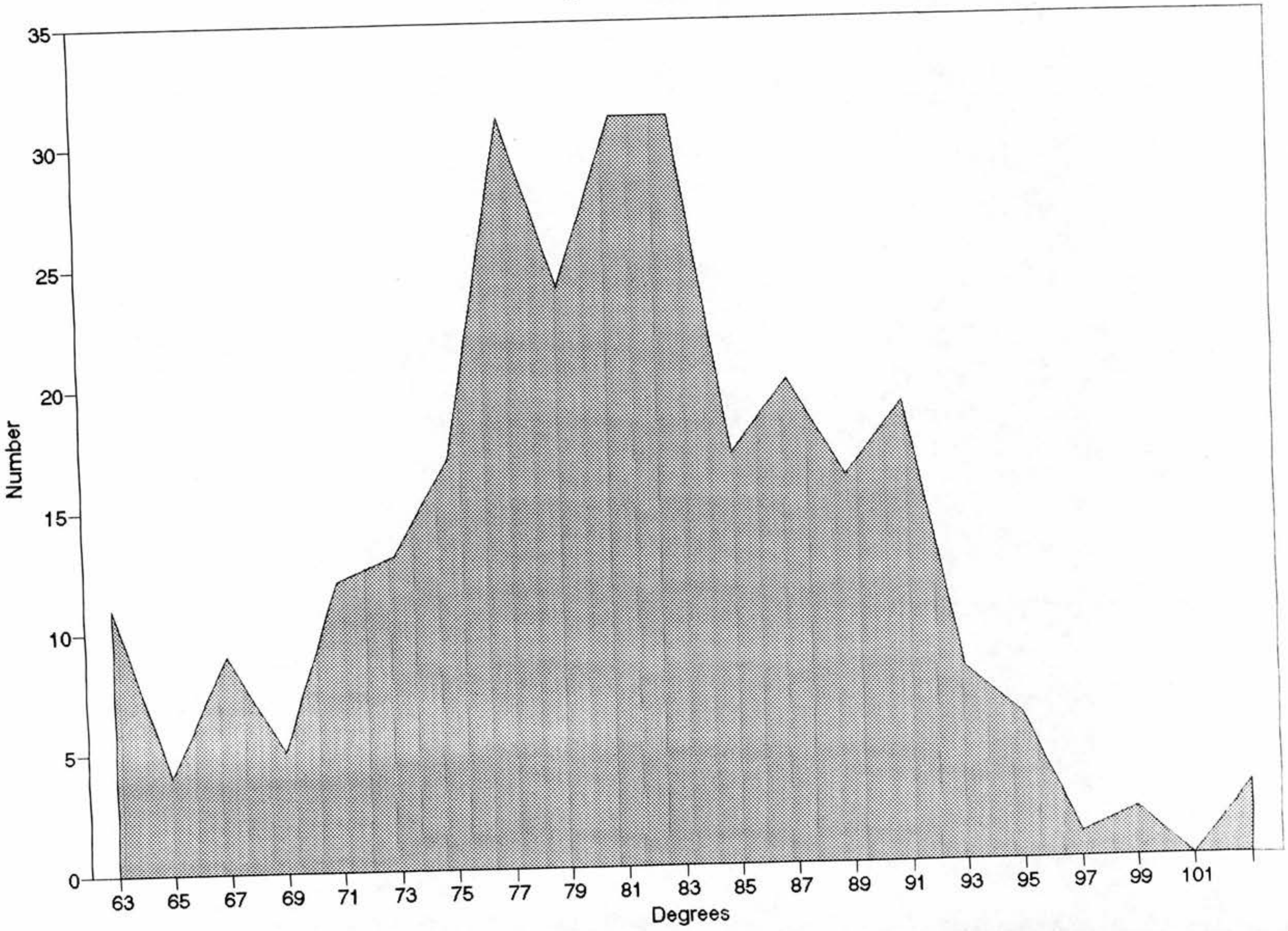


Fig 6.49: Pyramidal cores, platform angles frequency

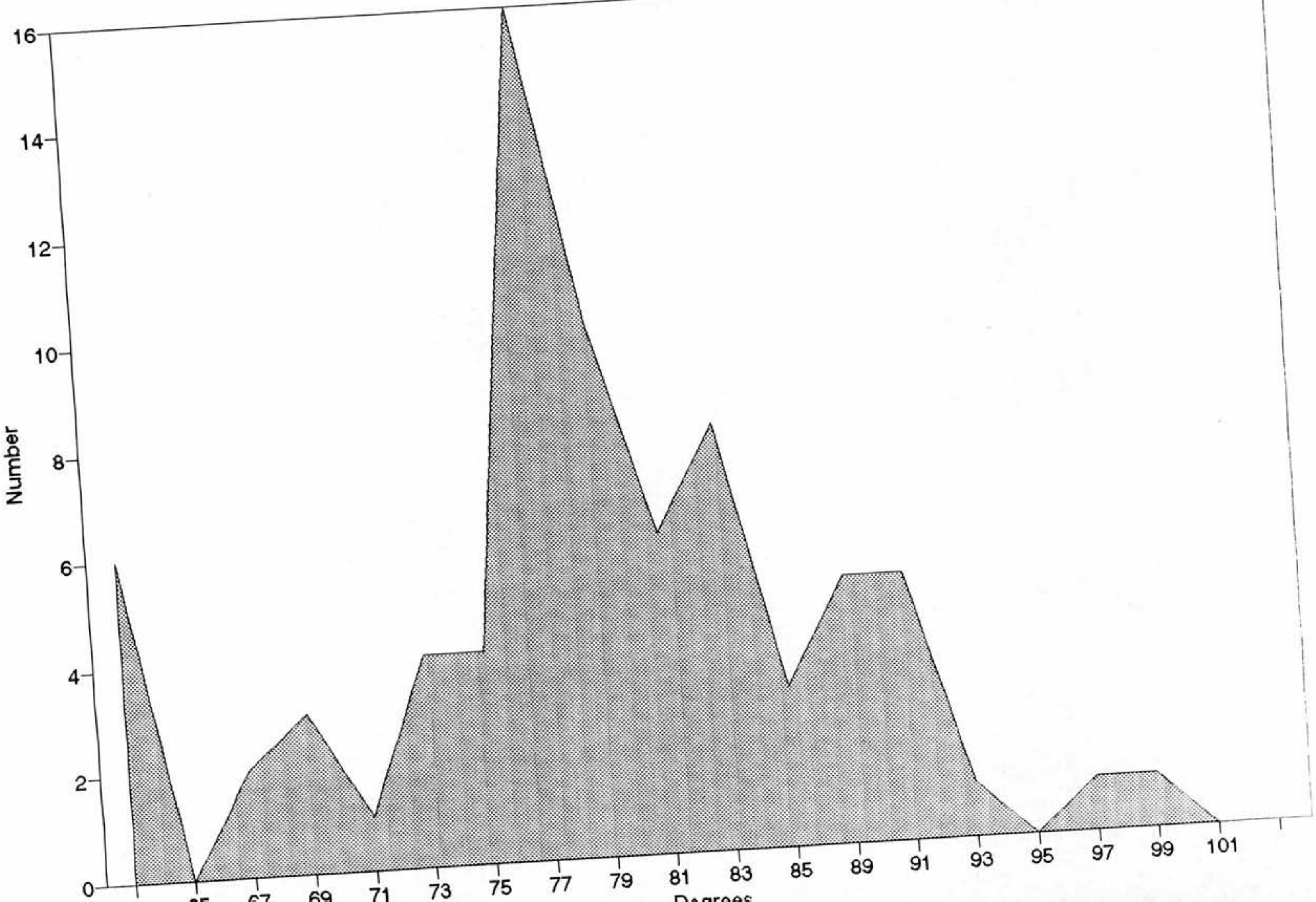


Fig 6.50: Cobble cores, platform angles frequency

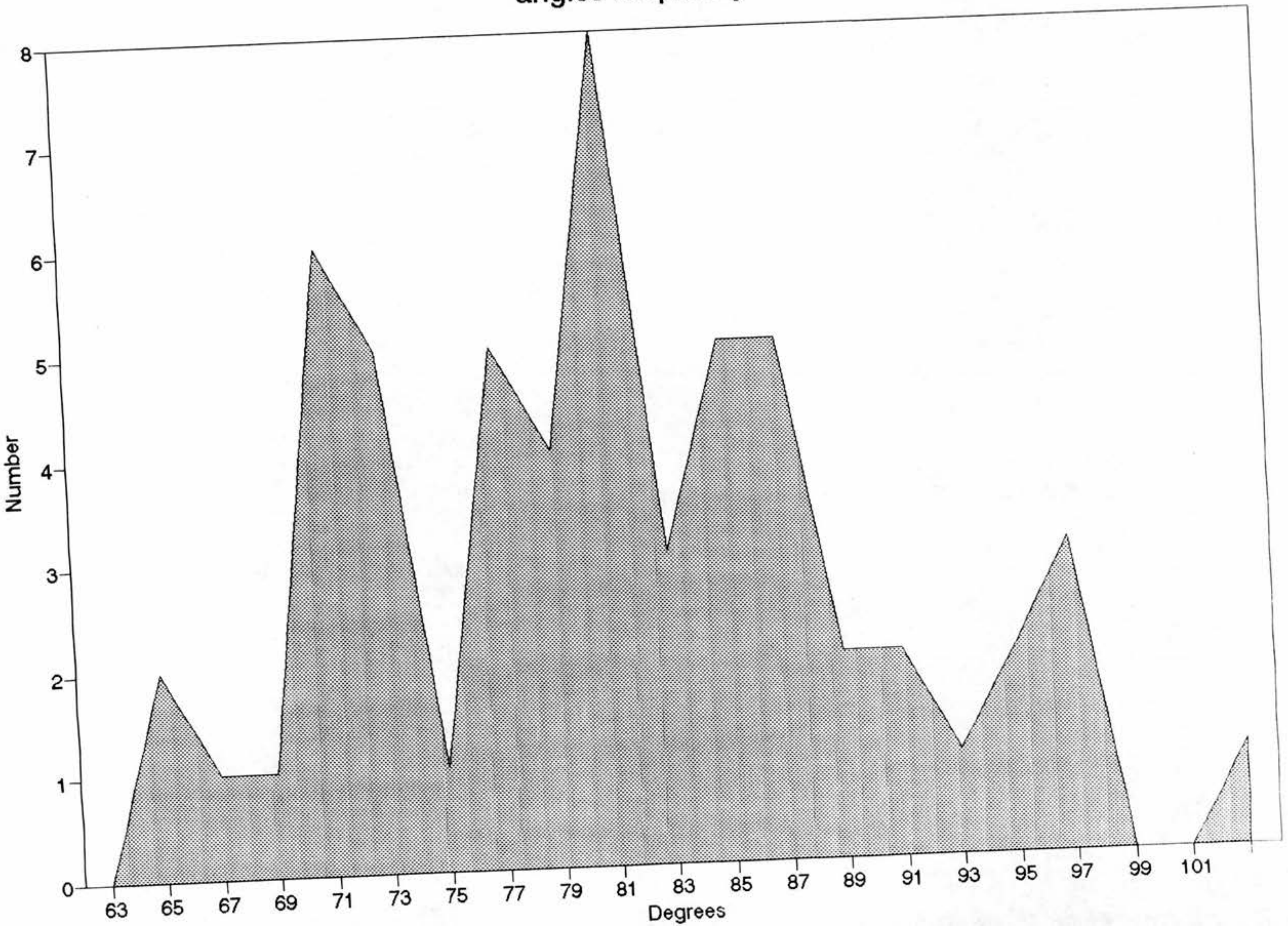


Fig 6.51: Flake cores, platform angles frequency

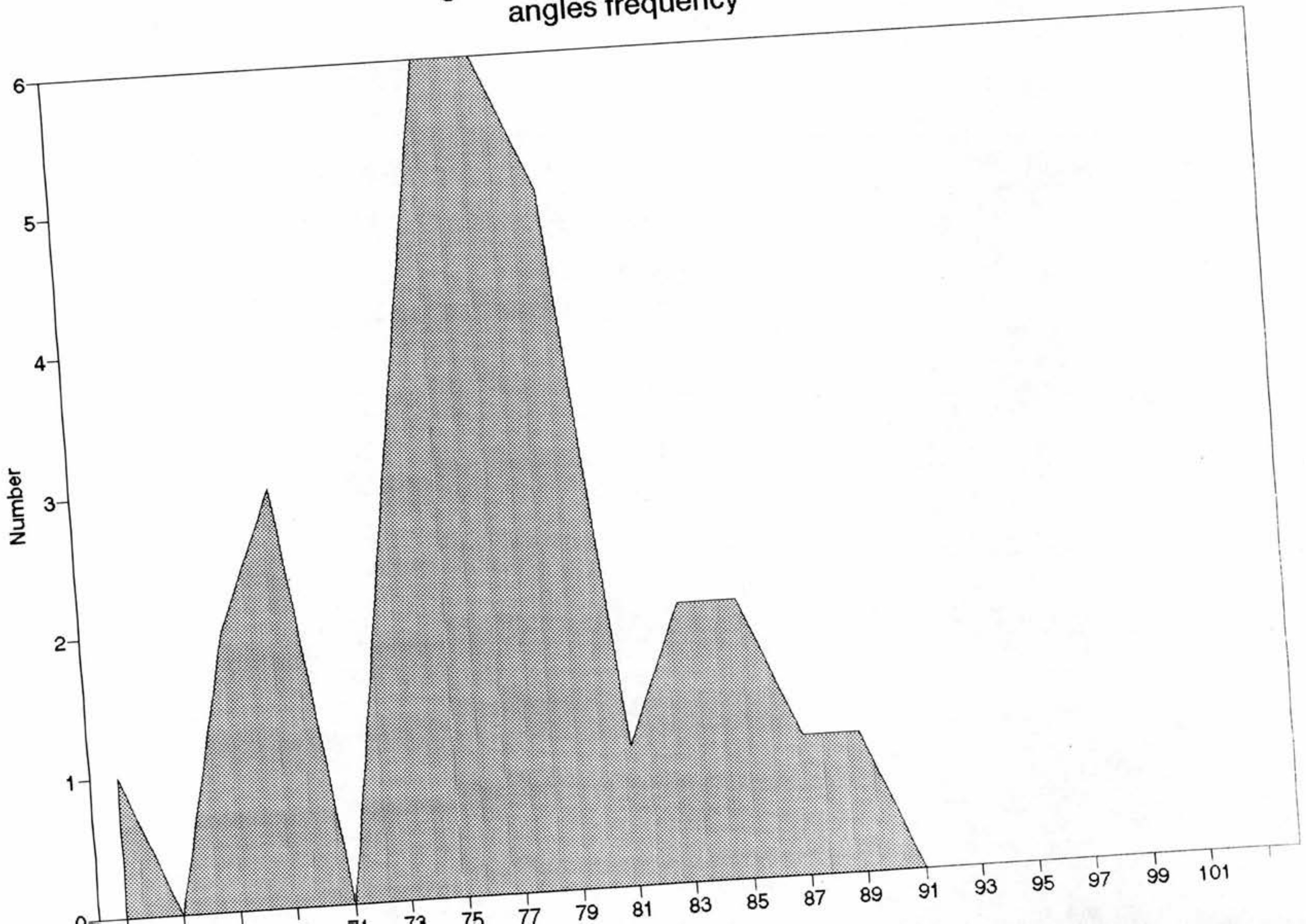


Fig 6.52:Naviform cores sensu lato size
Contextual variation

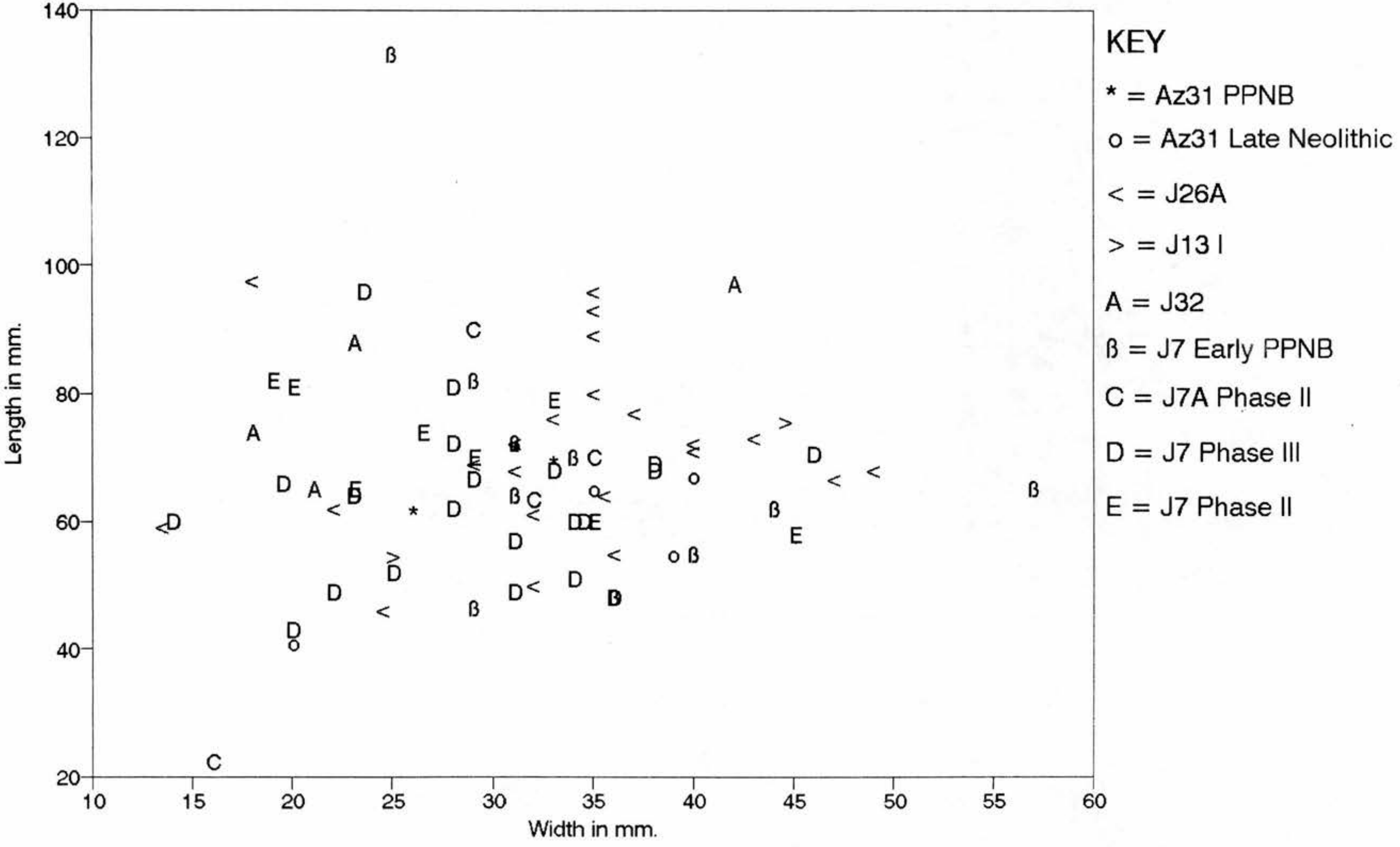


Fig 6.53: Naviform core shape and size.
Contextual variation.

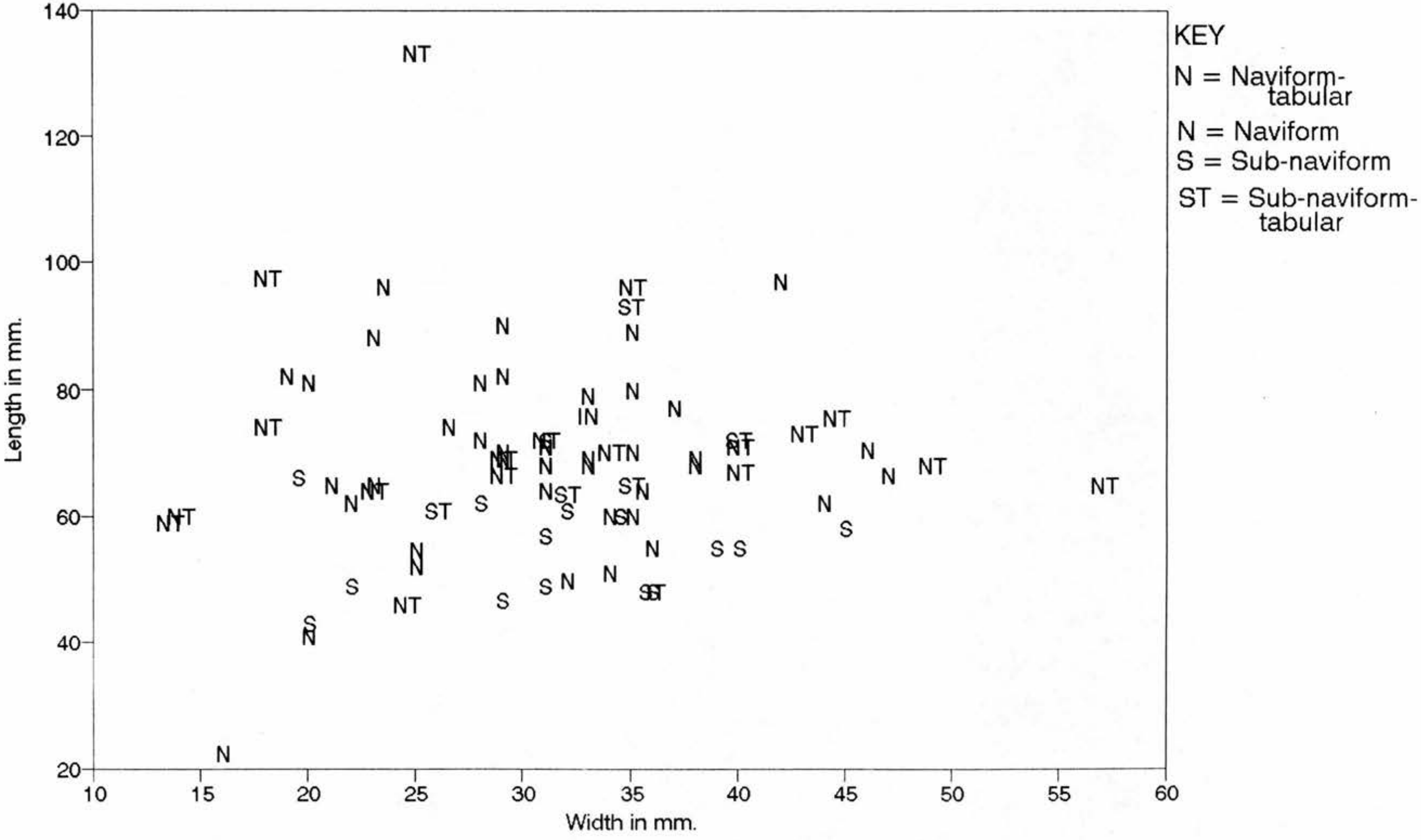


Fig 6.54:Sub-naviform core shape & size
Contextual variation

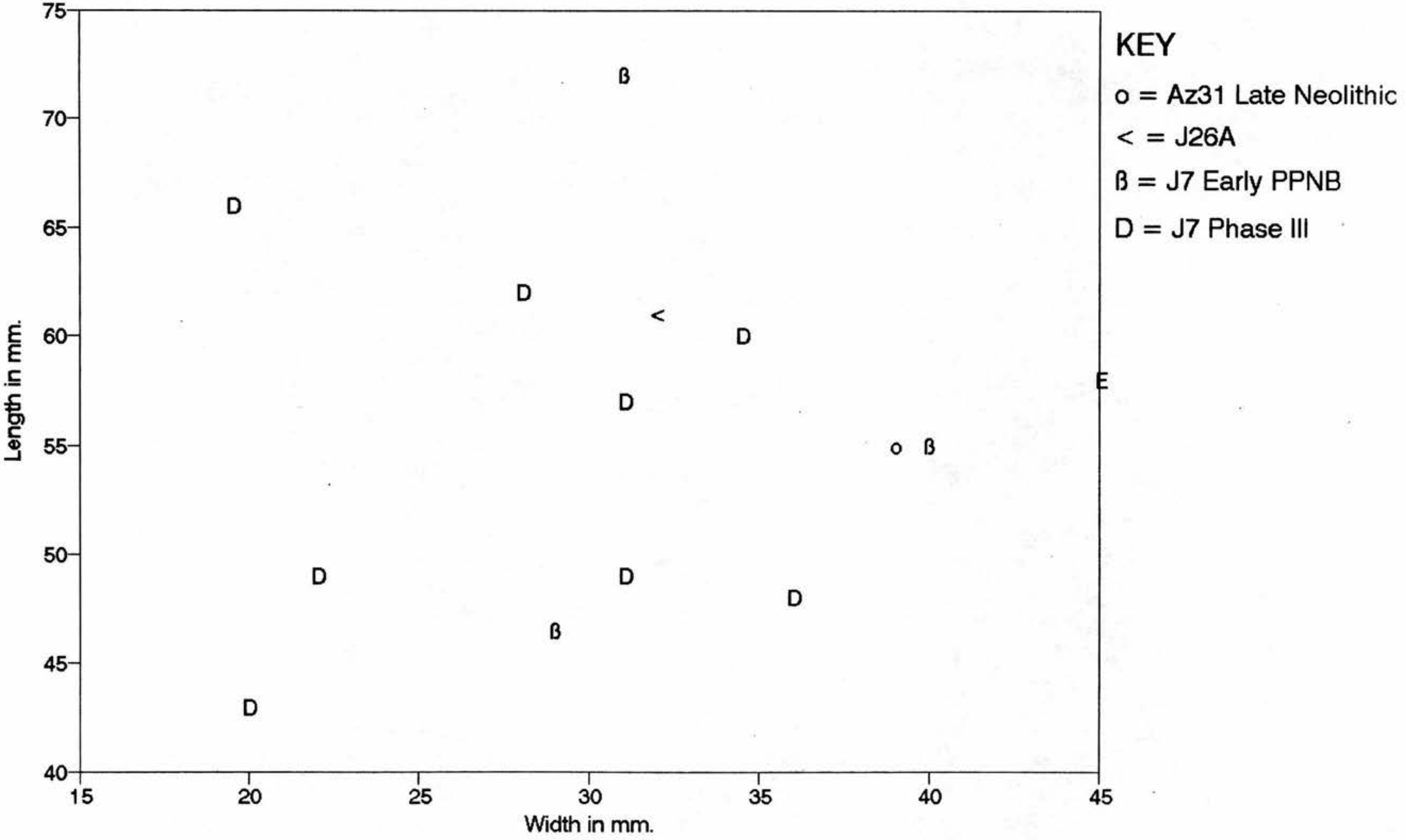


Fig 6.55: Naviform-tabular core shape and size. Contextual variation.

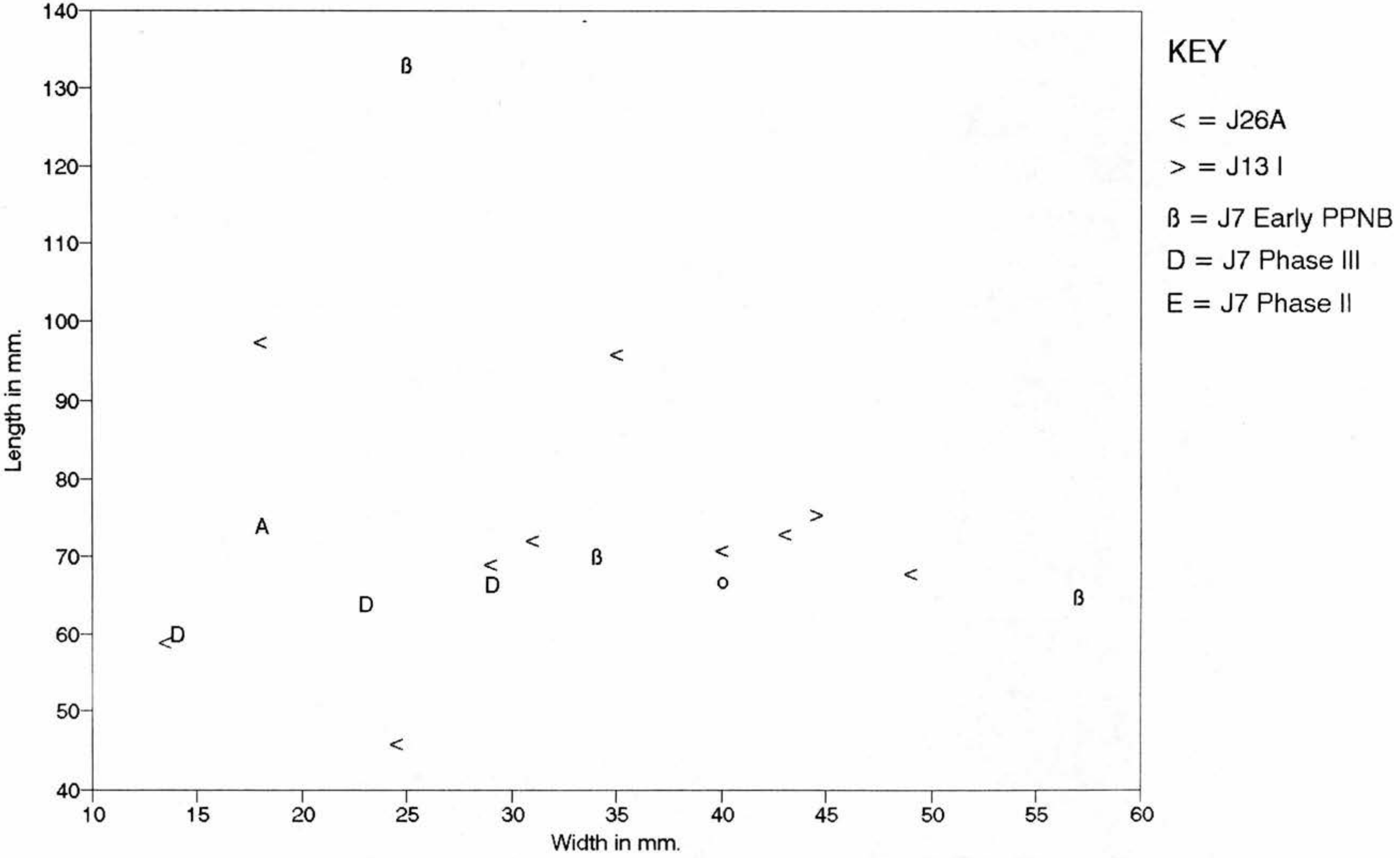


Fig 6.56: Sub-naviform-tabular core shape and size. Contextual variation.

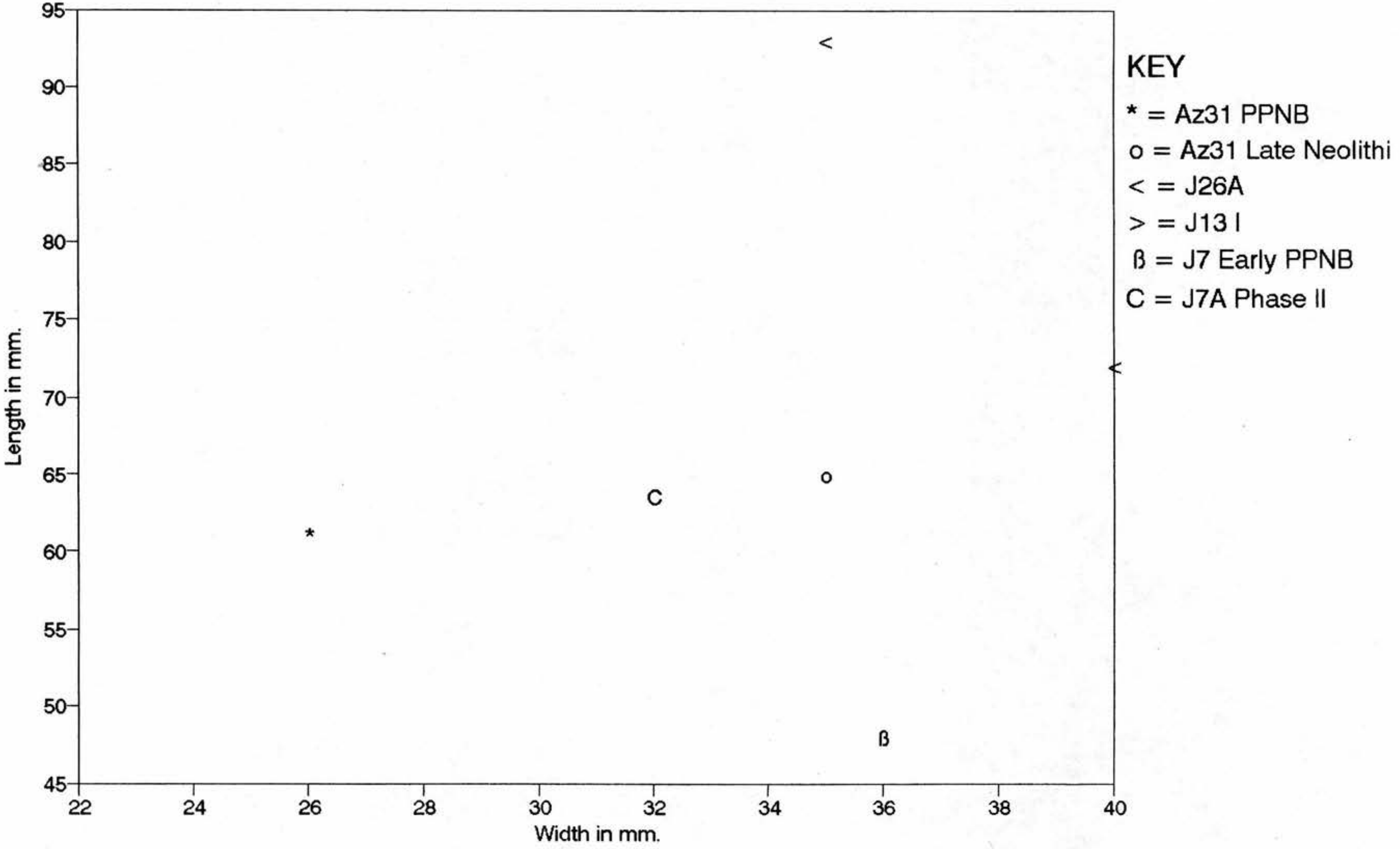


Fig 6.57: Naviform cores sensu stricto shape and size. Contextual variation.

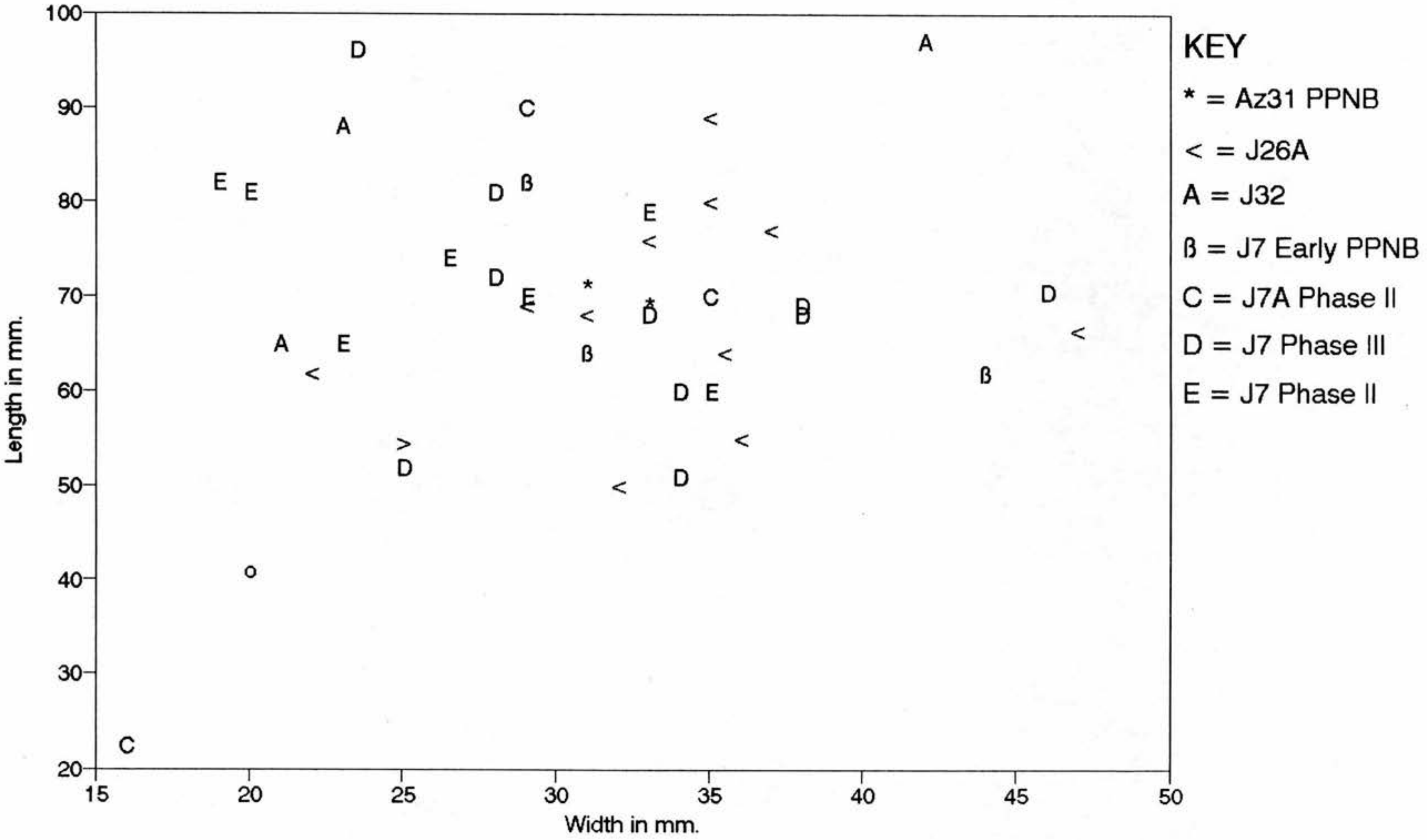


Fig 6.58: J7 Early PPNB non-naviform core size. Length:Width

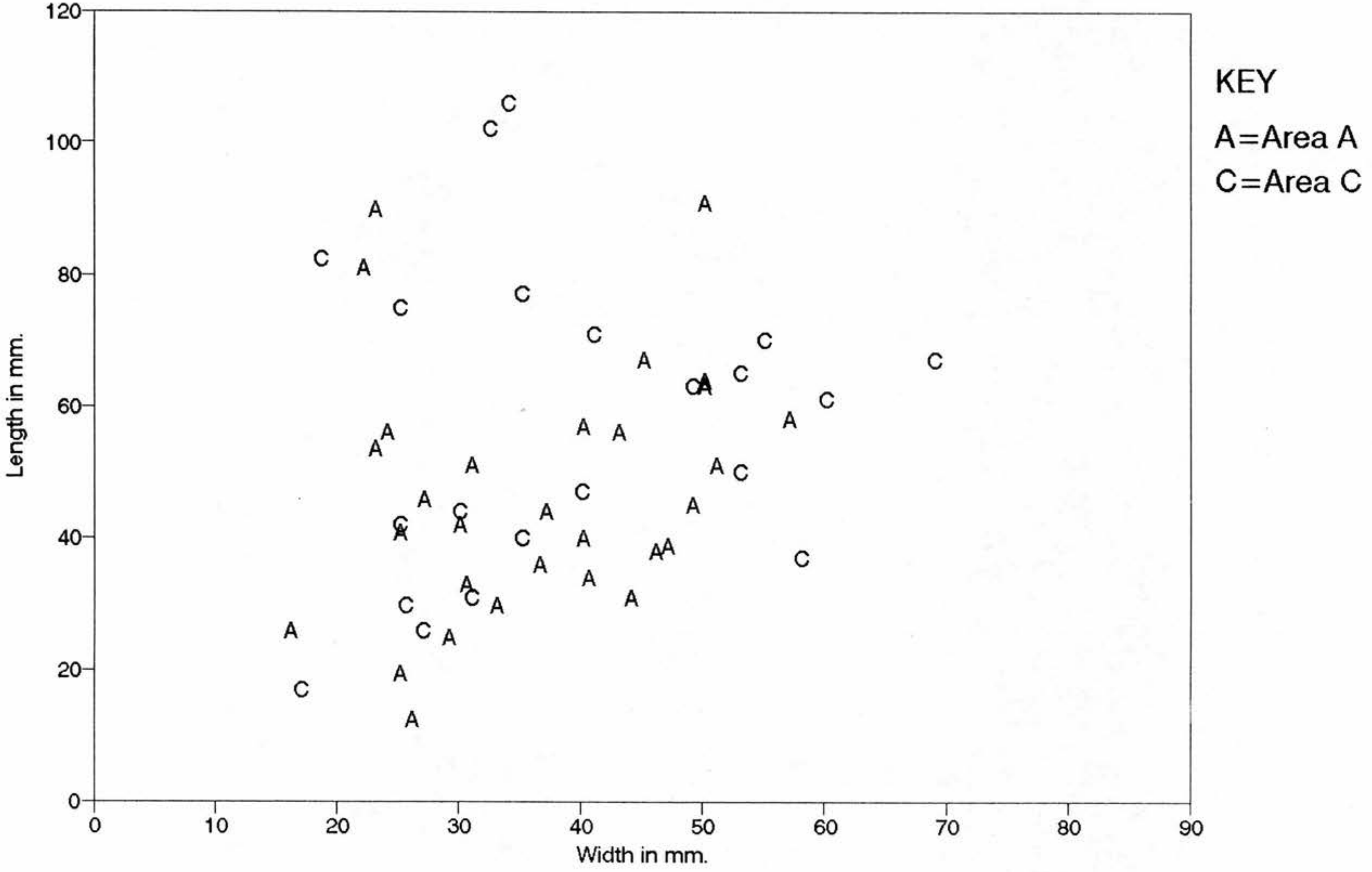


Fig 6.59: J32 and J7 Phase II
non-naviform core size. Length:Width

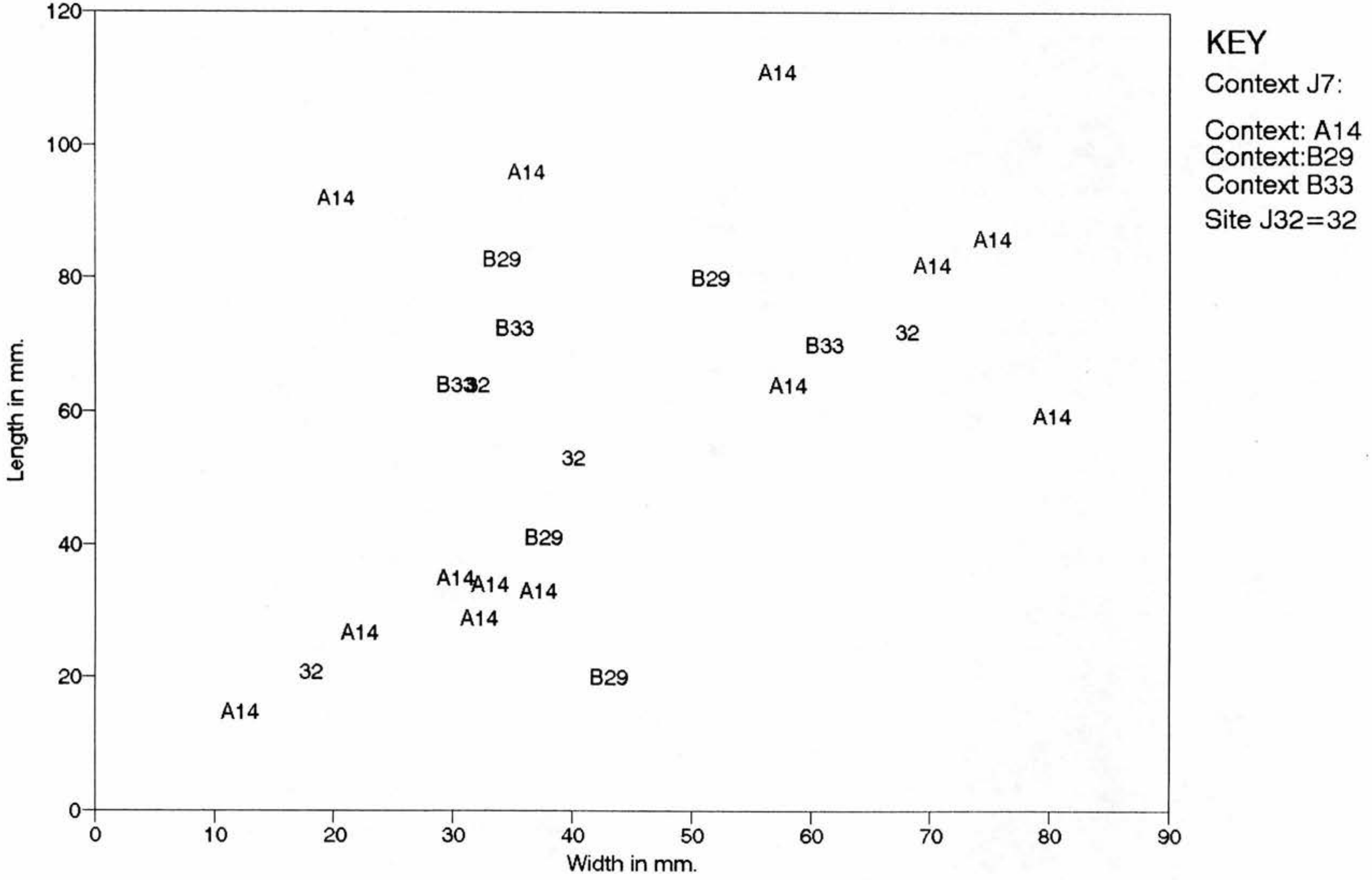


Fig 6.60: J26 non-naviform core size
Length:Width

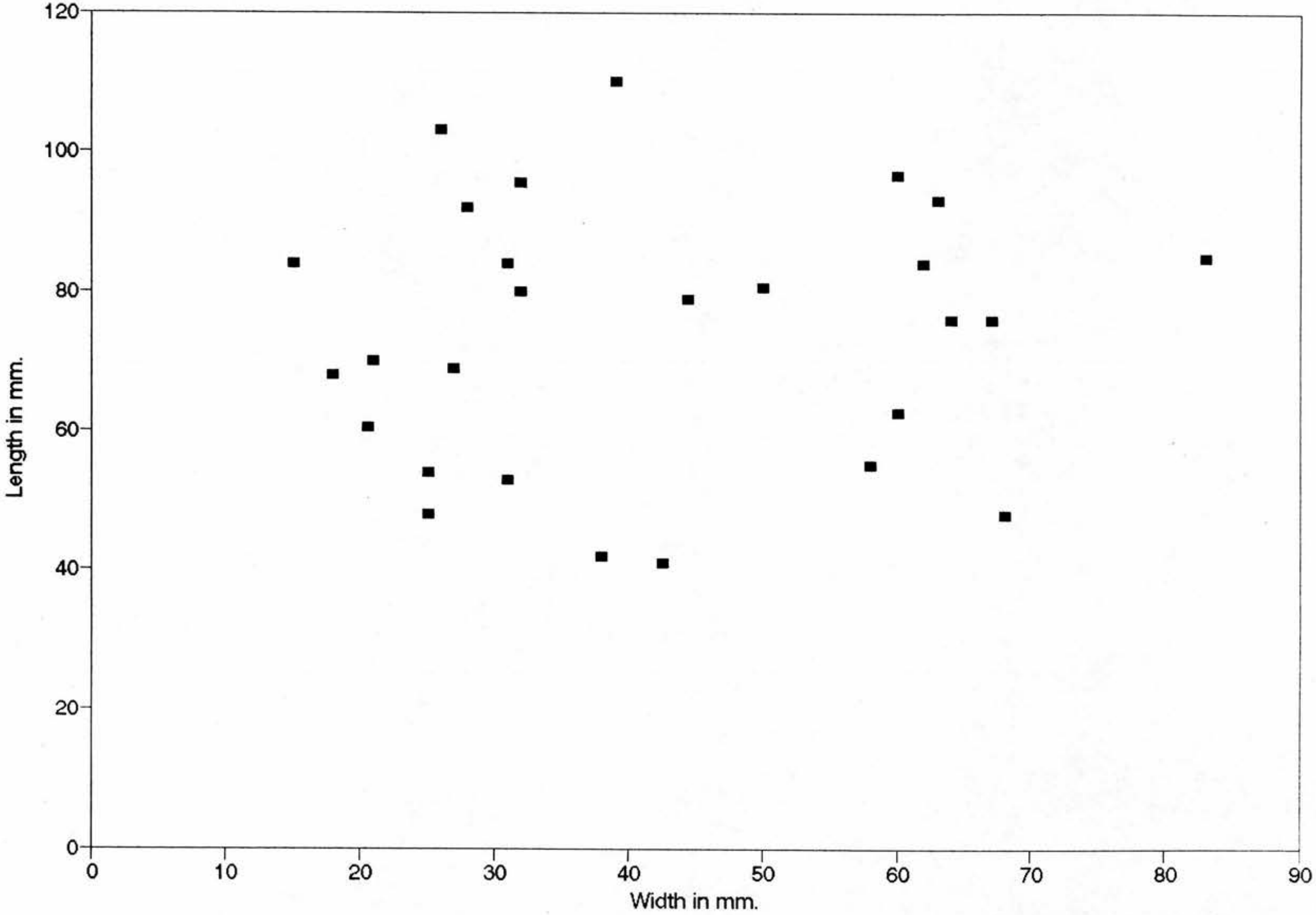


Fig 6.61:J7 Phase III non-naviform core size. Length:Width

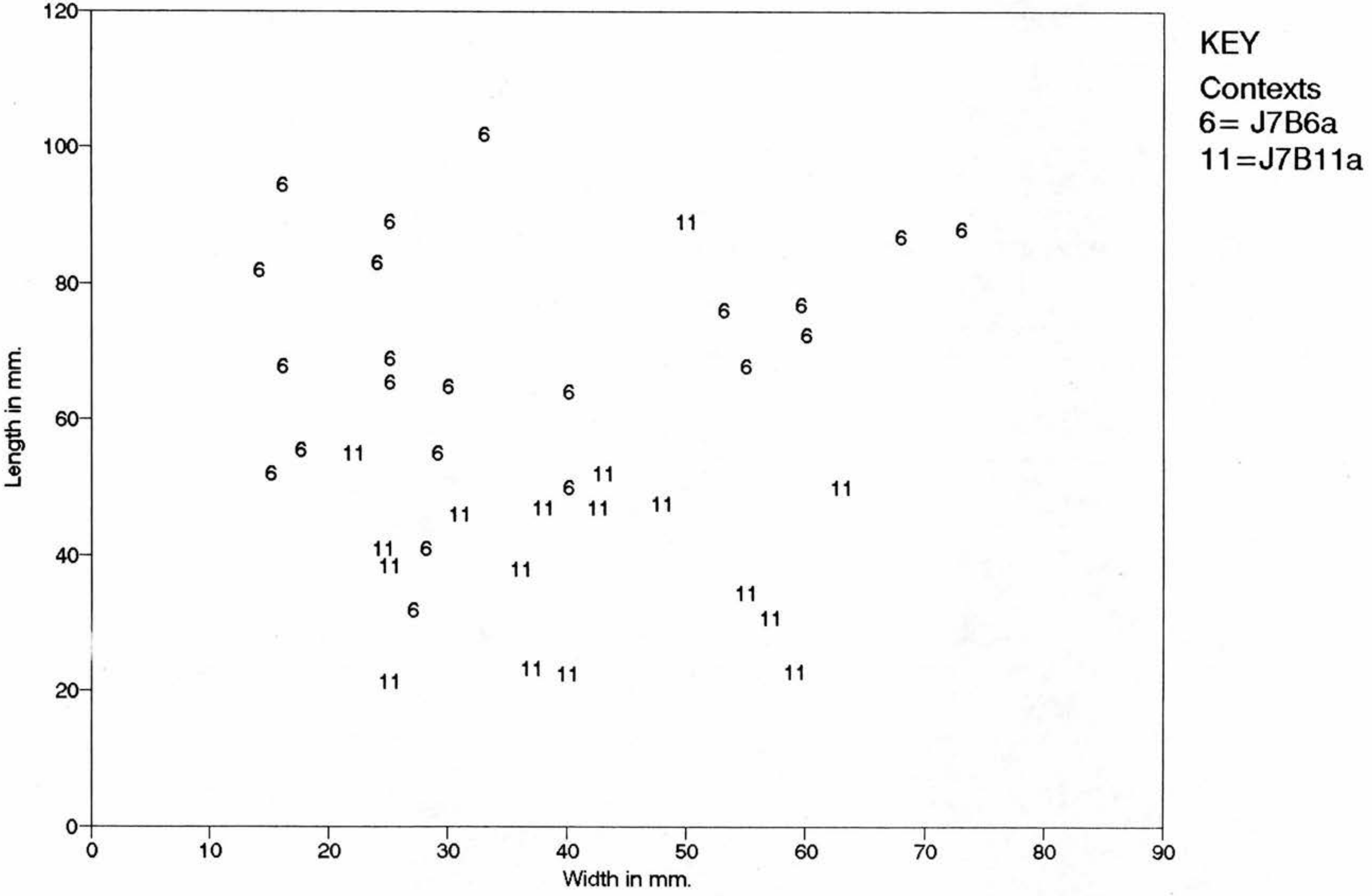


Fig 6.62: J13 and Azraq 31 core size
Length:Width

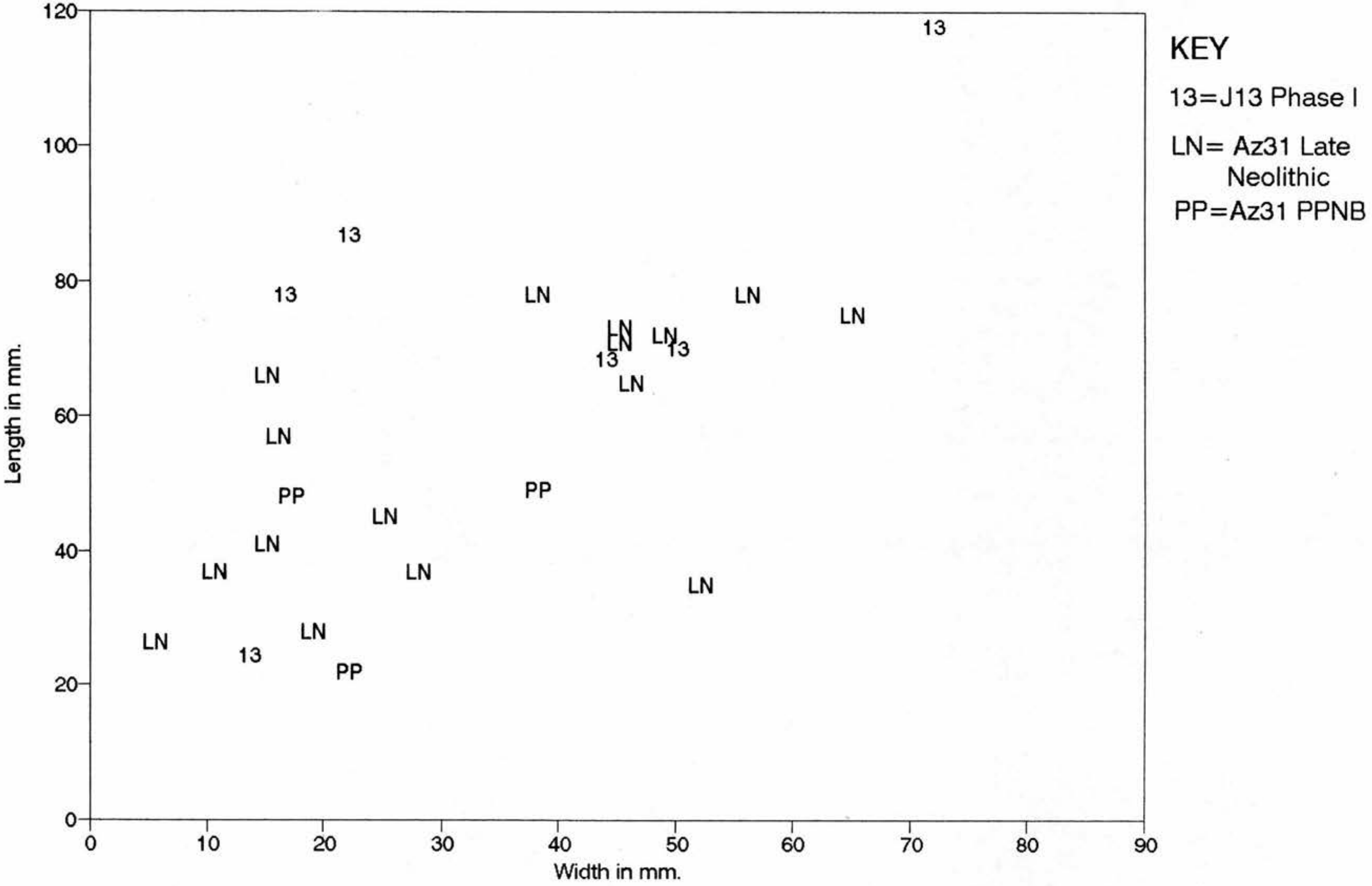


Fig 6.64: J7 Early PPNB cores, platform angles frequency

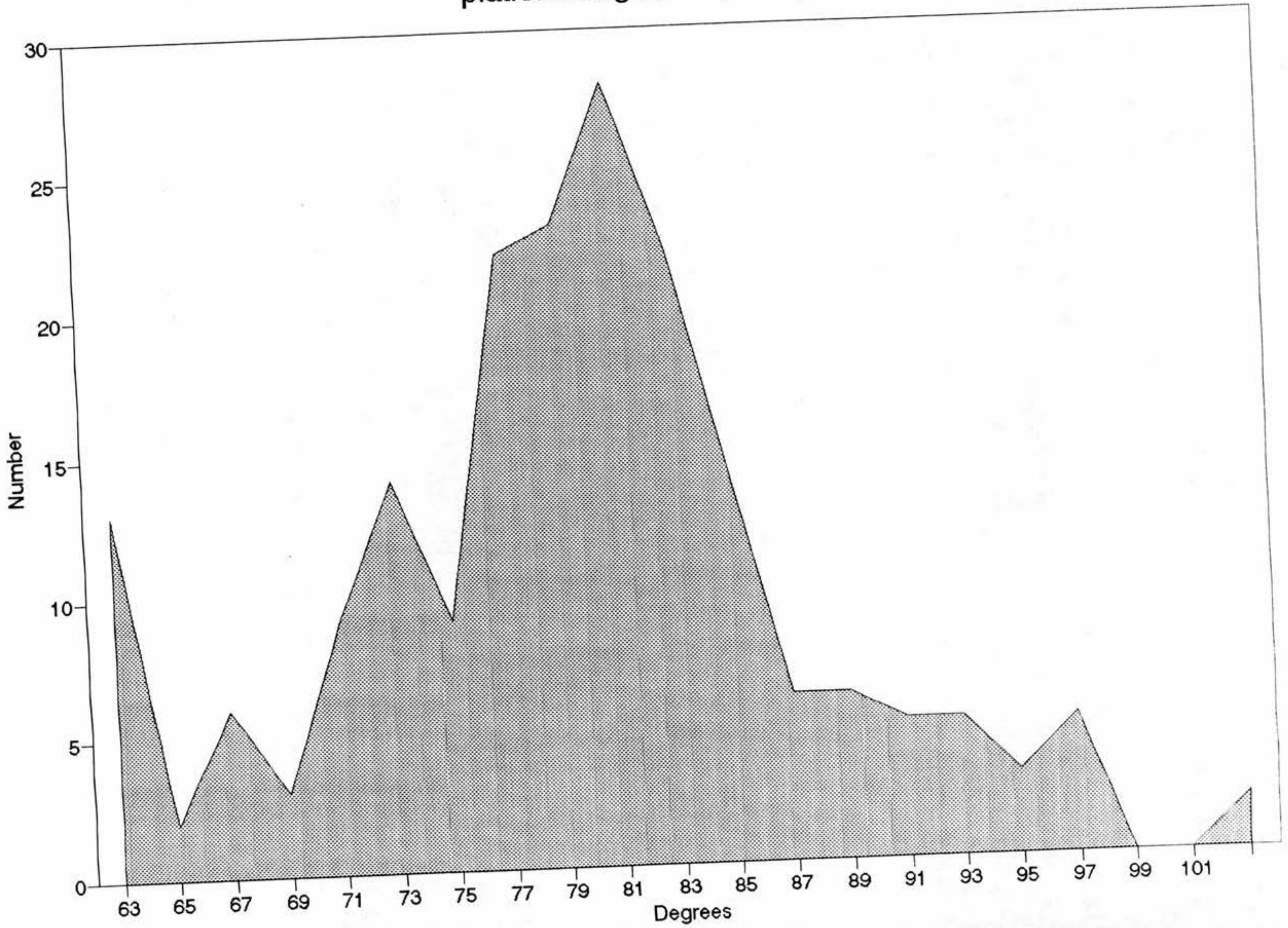


Fig 6.65: J26 platform angles frequency

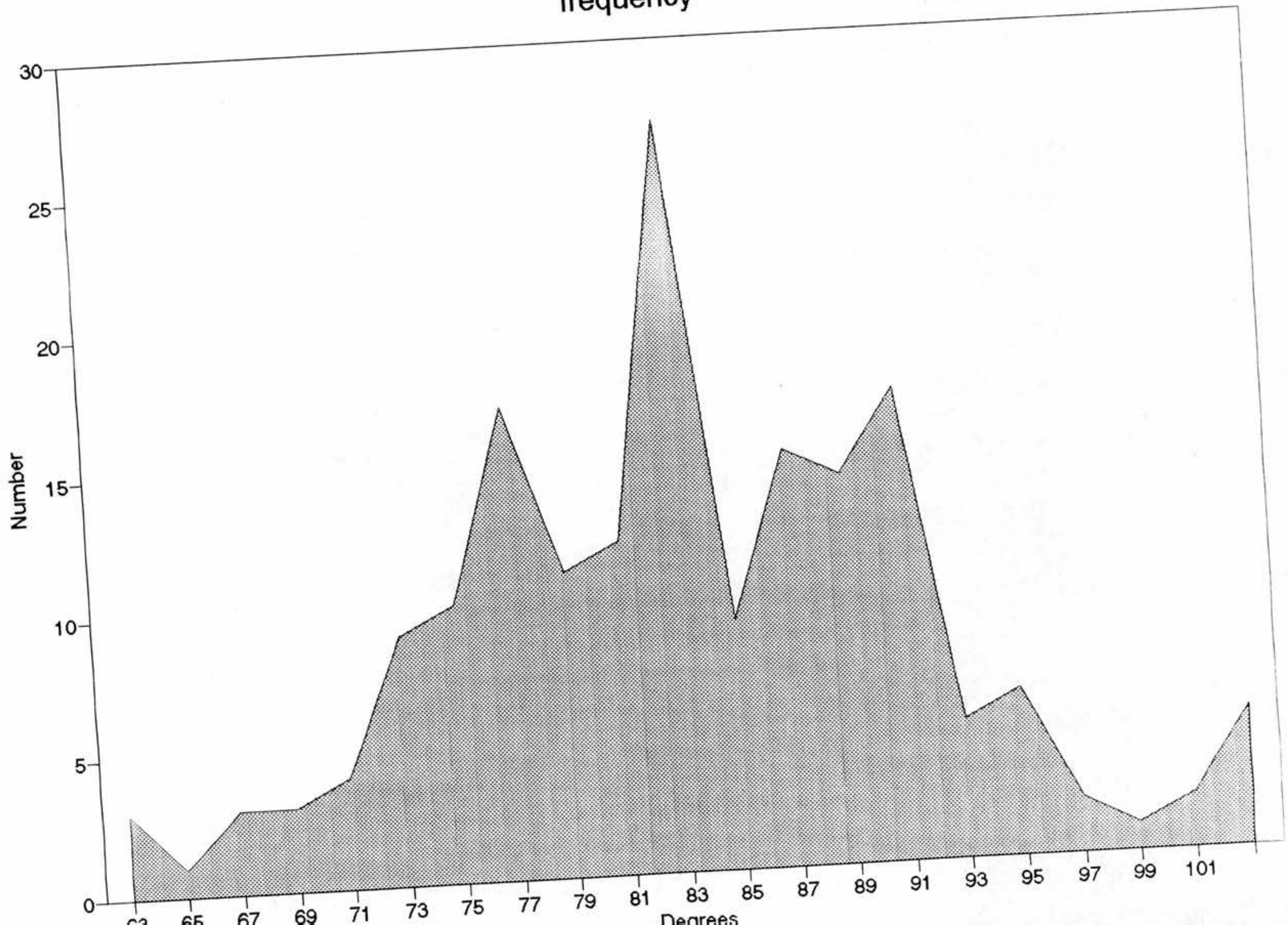


Fig 6.66: J7 Phase II cores, platform angles frequency

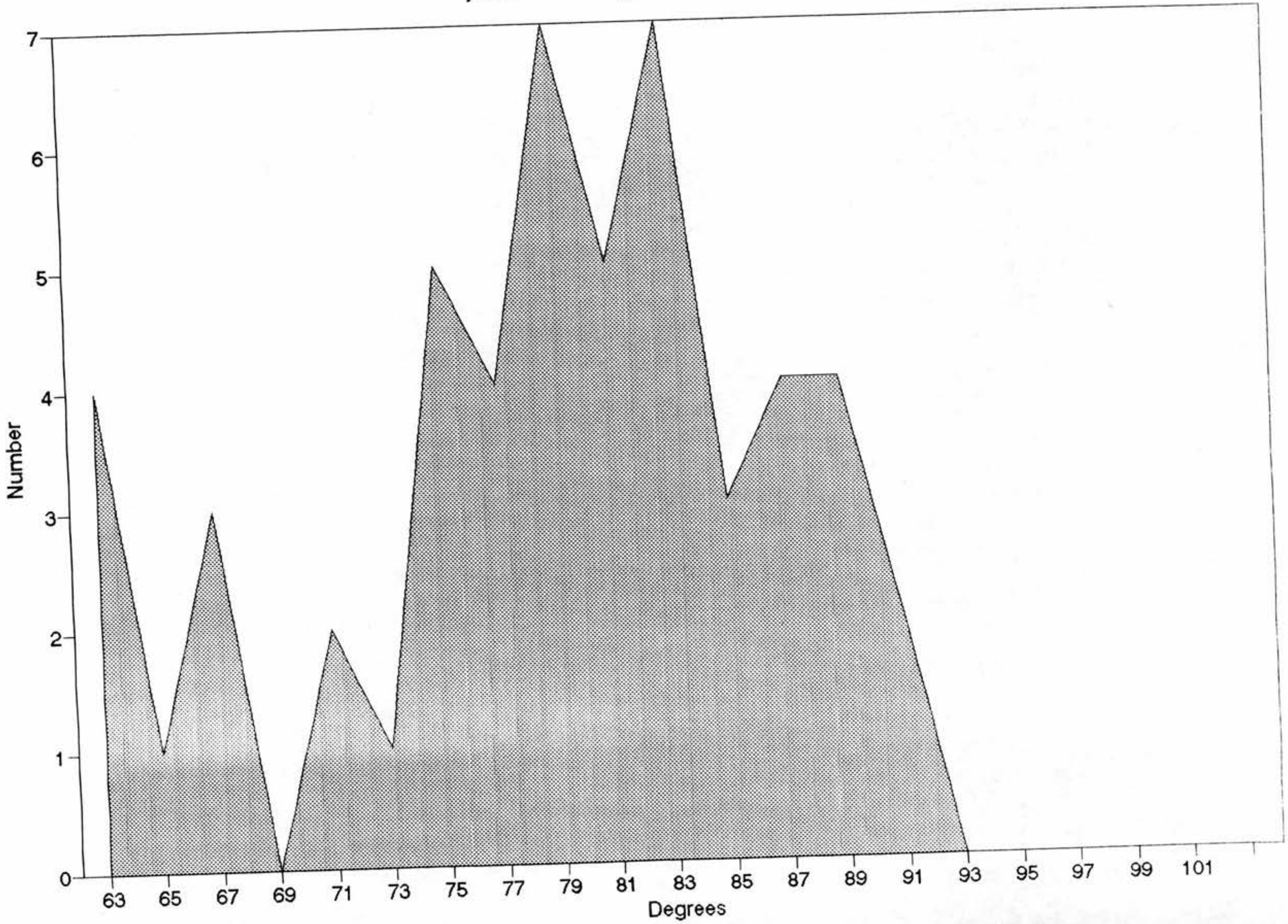


Fig 6.67: J7 Phase III cores,
platform angles frequency

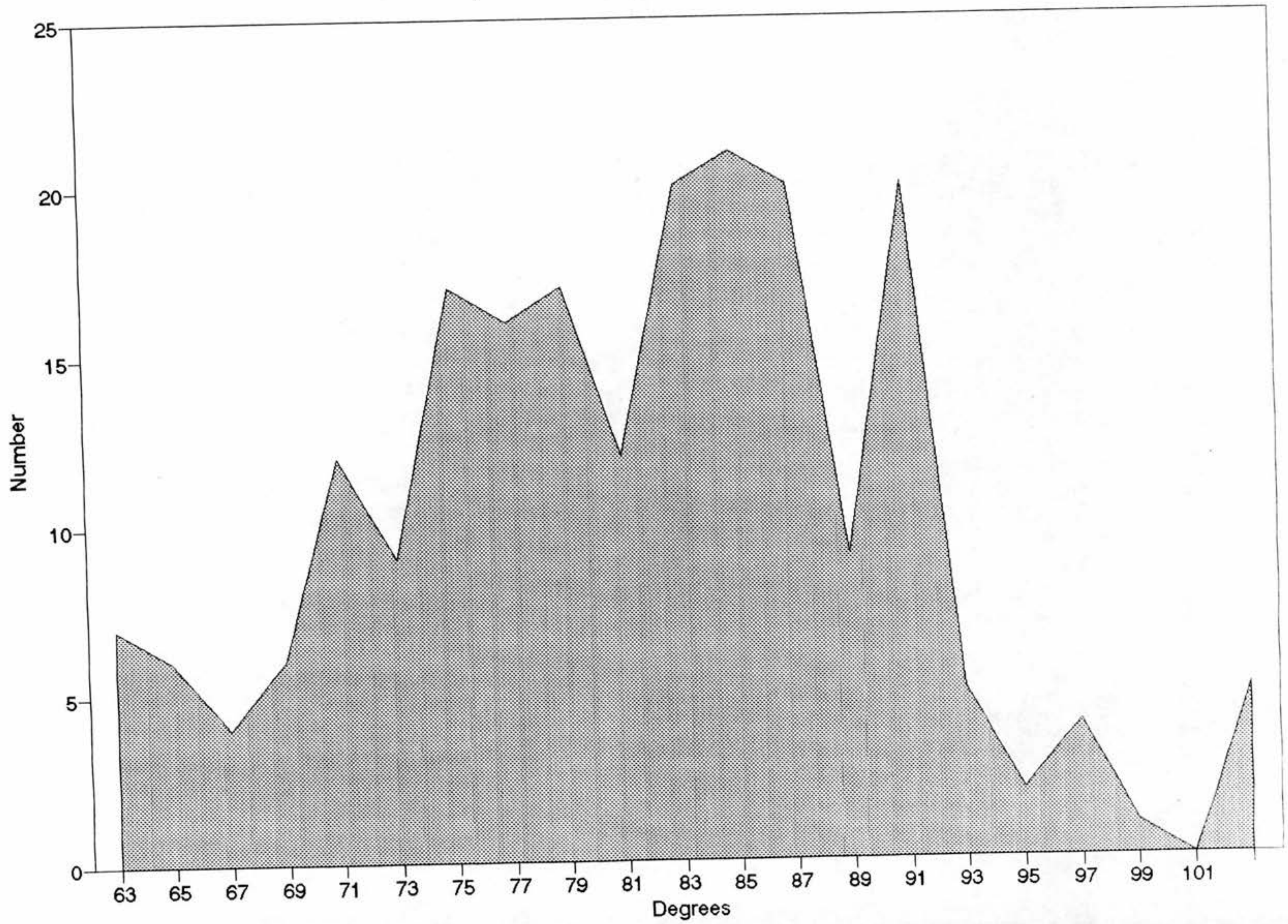


Fig 6.68: J7 Early PPNB
Proportions of flakes & blade-bladelets

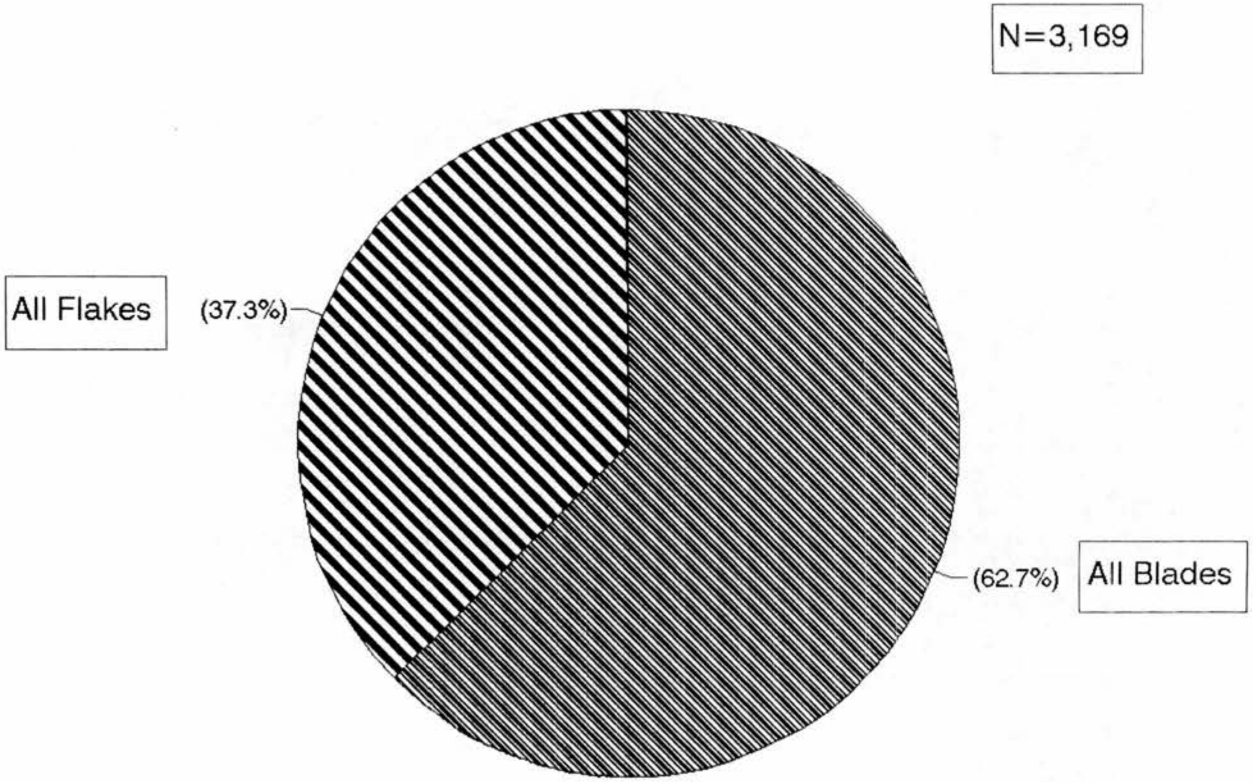


Fig 6.69: J7 Area A upper levels
Proportions of flakes & blade-bladelets

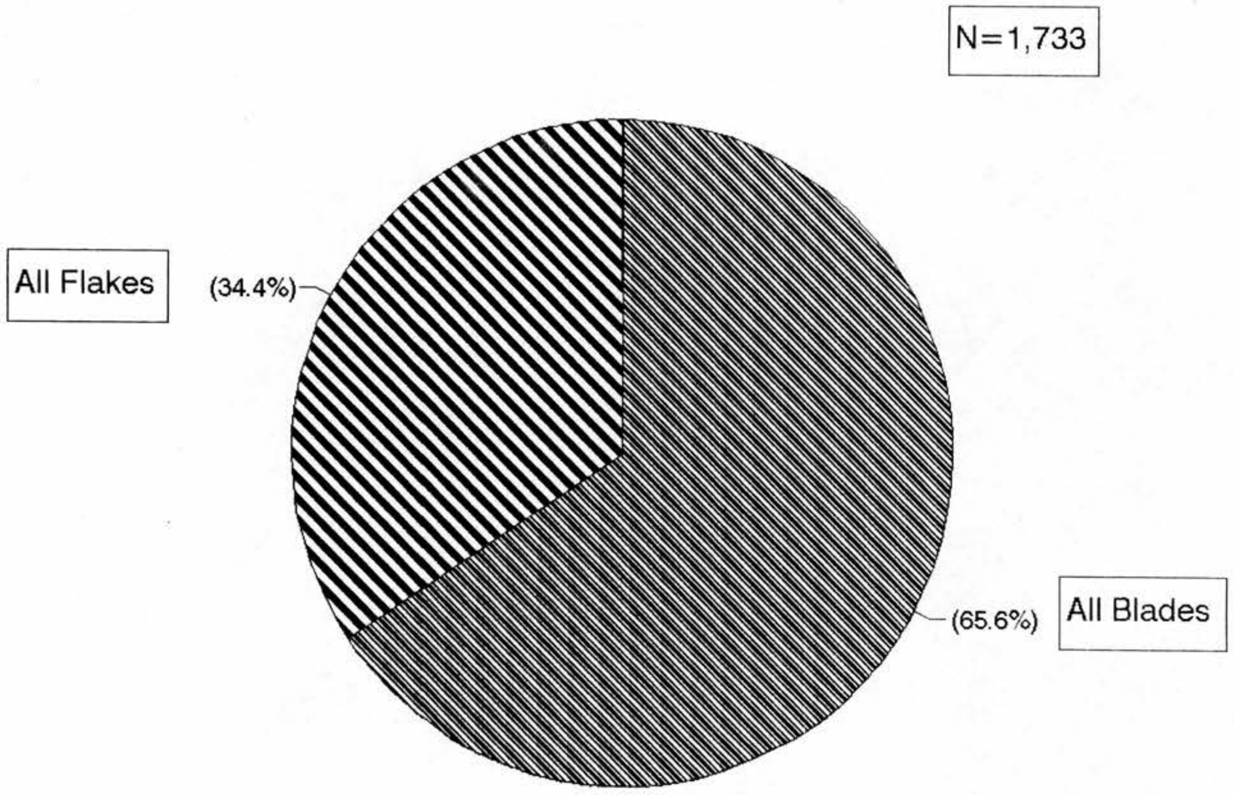


Fig 6.70: J7 Phase II
Proportions of flakes & blade-bladelets

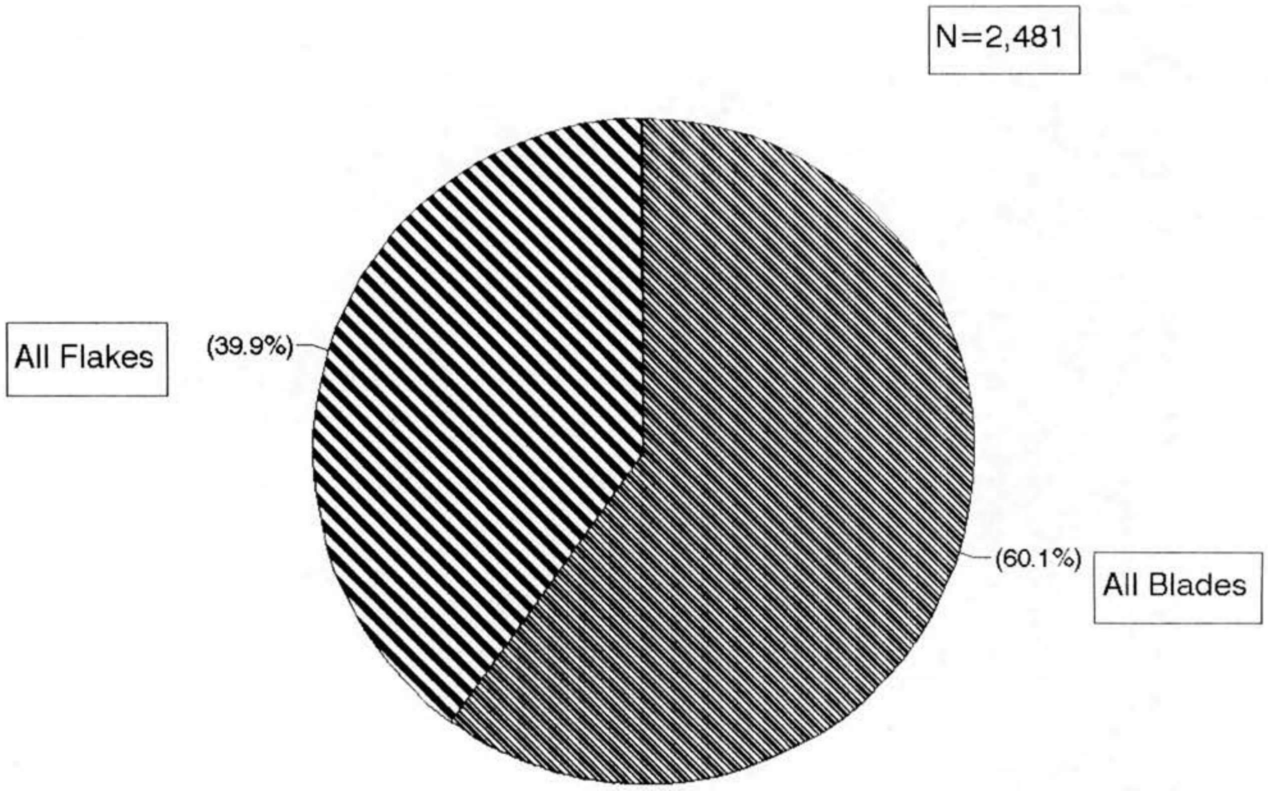


Fig 6.71: J7 Phase III
Proportions of flakes & blade-bladelets

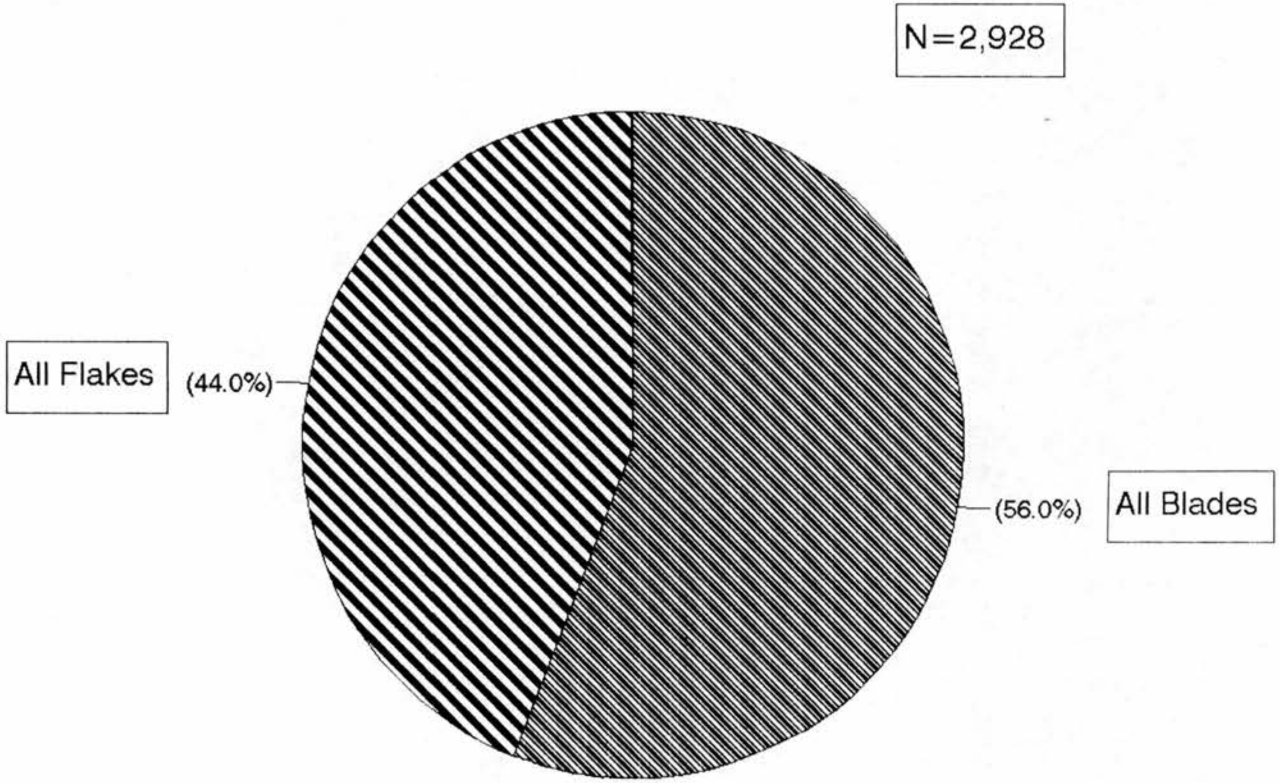


Fig. 6.72 J26 Proportions of flakes and blades-bladelets

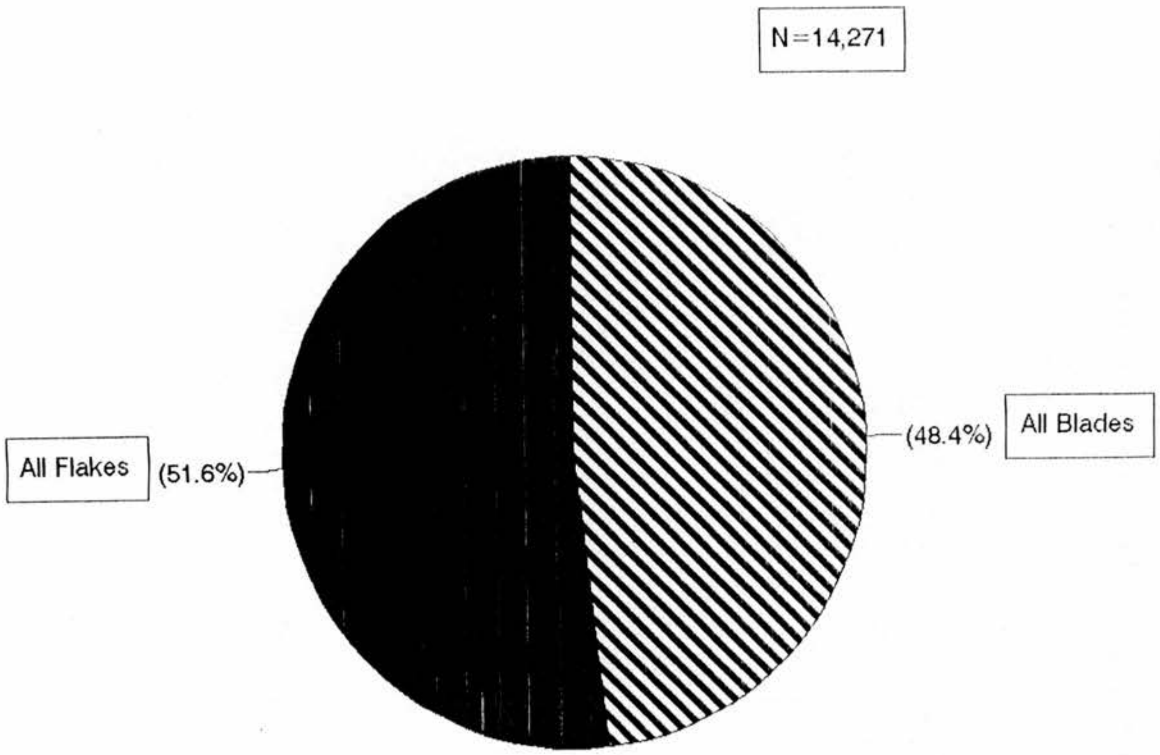


Fig. 6.73 Azraq 31 PPNB
Proportions of flakes to blade-bladelet

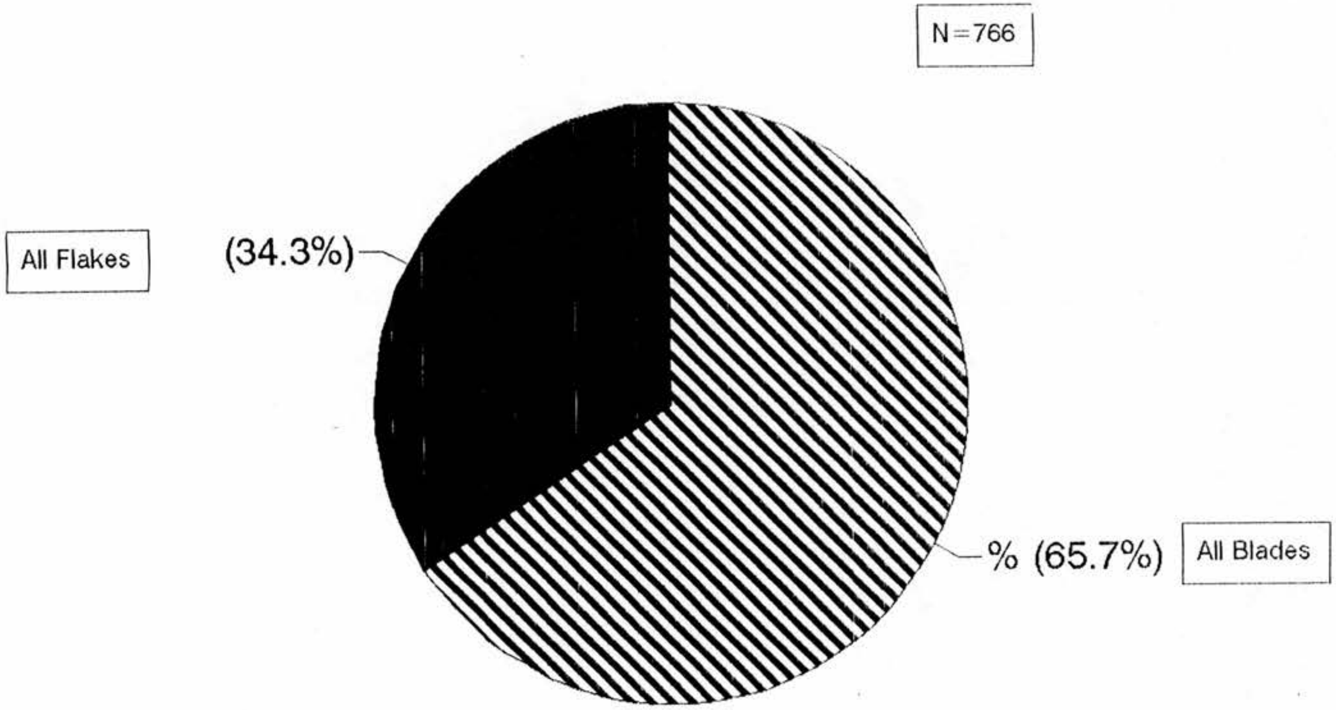


Fig. 6.74 Azraq 31 Late Neolithic
Proportions of flakes to blade-bladelet

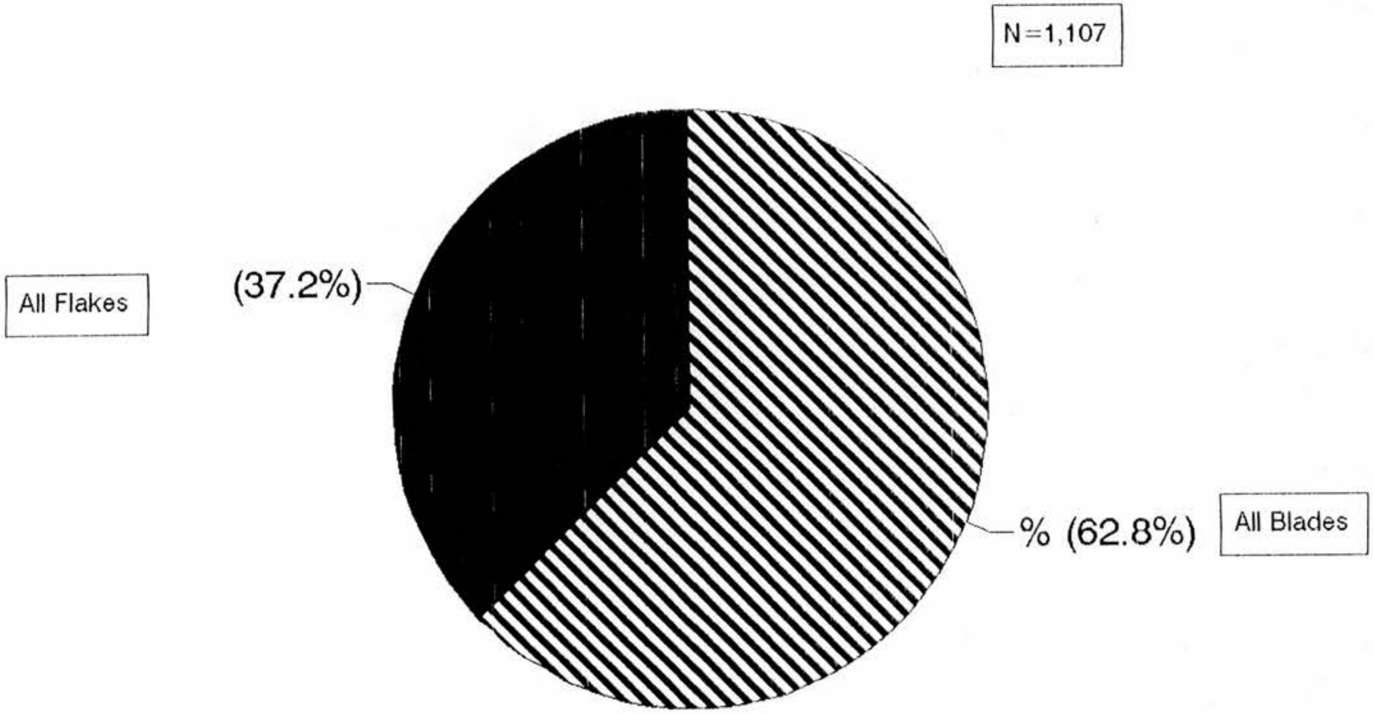


Fig. 6.75 J13 Early Phase, proportions of flakes and blade-bladelets

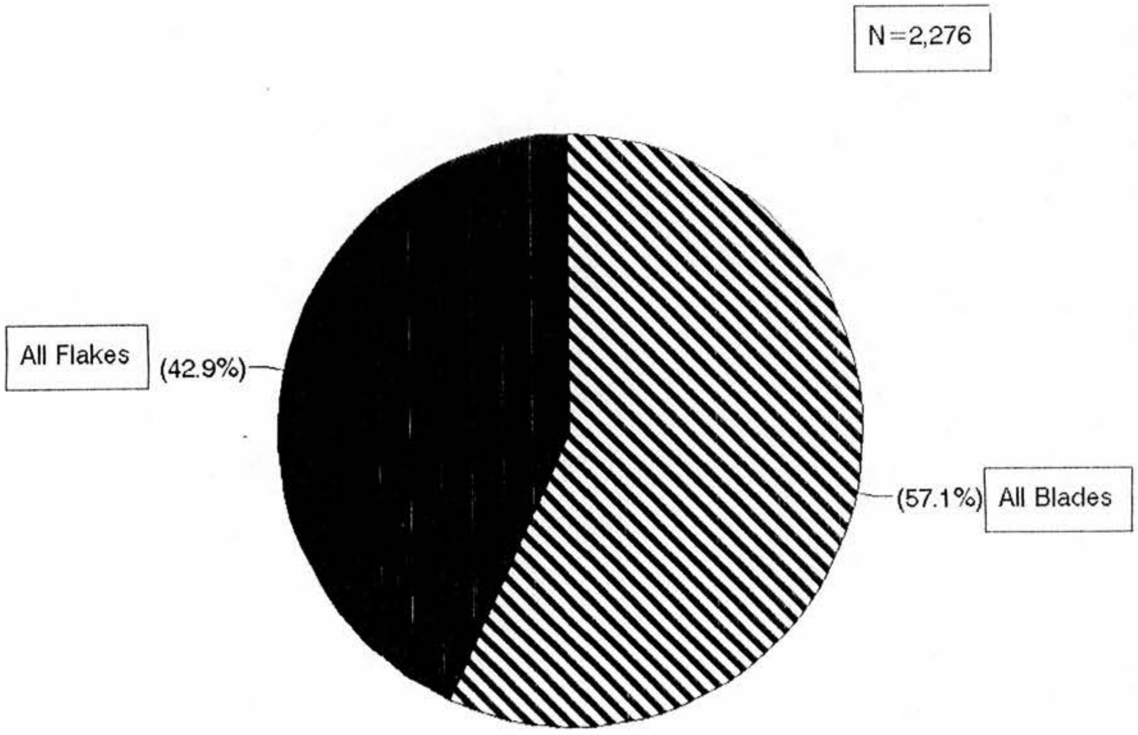


Fig 6.76: J13 Late Phase
Proportions of flakes & blade-bladelets

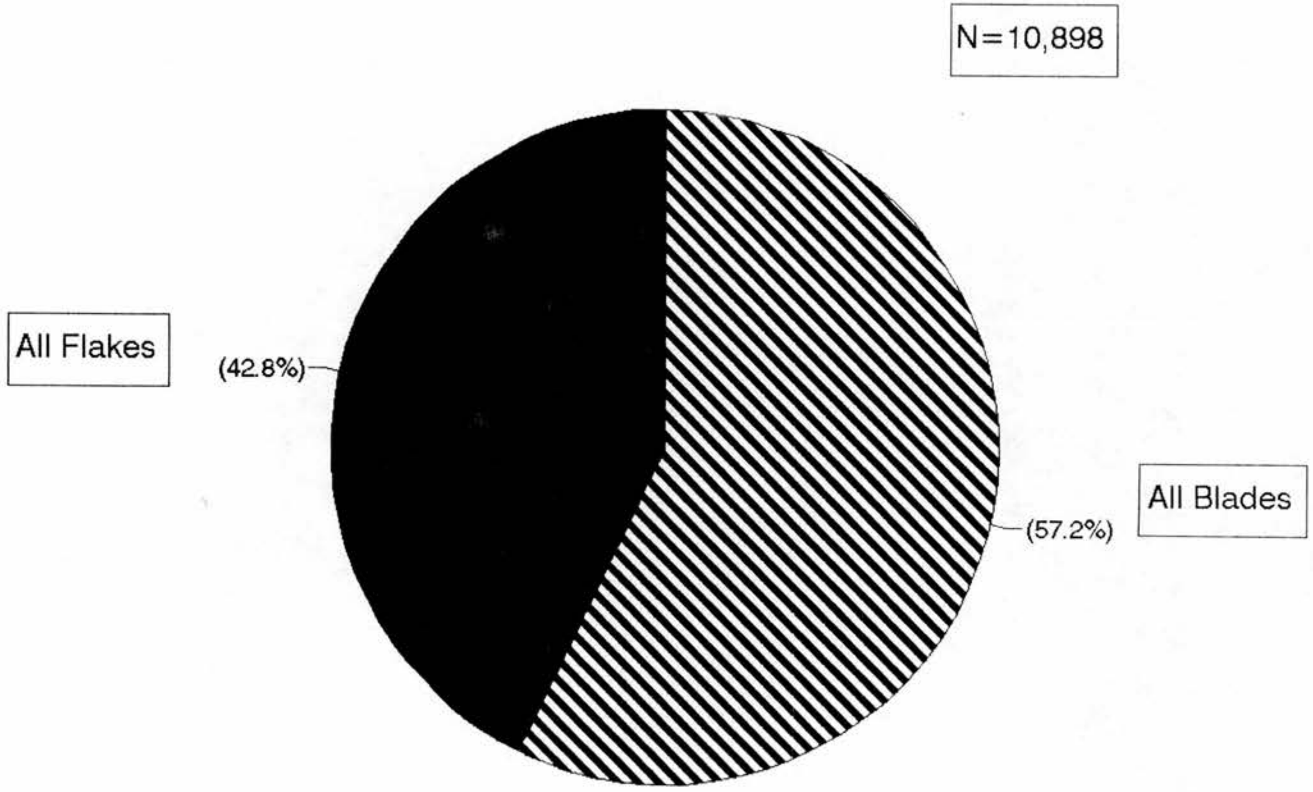


Fig. 6.77 J25 Proportion of flakes and blade-bladelets

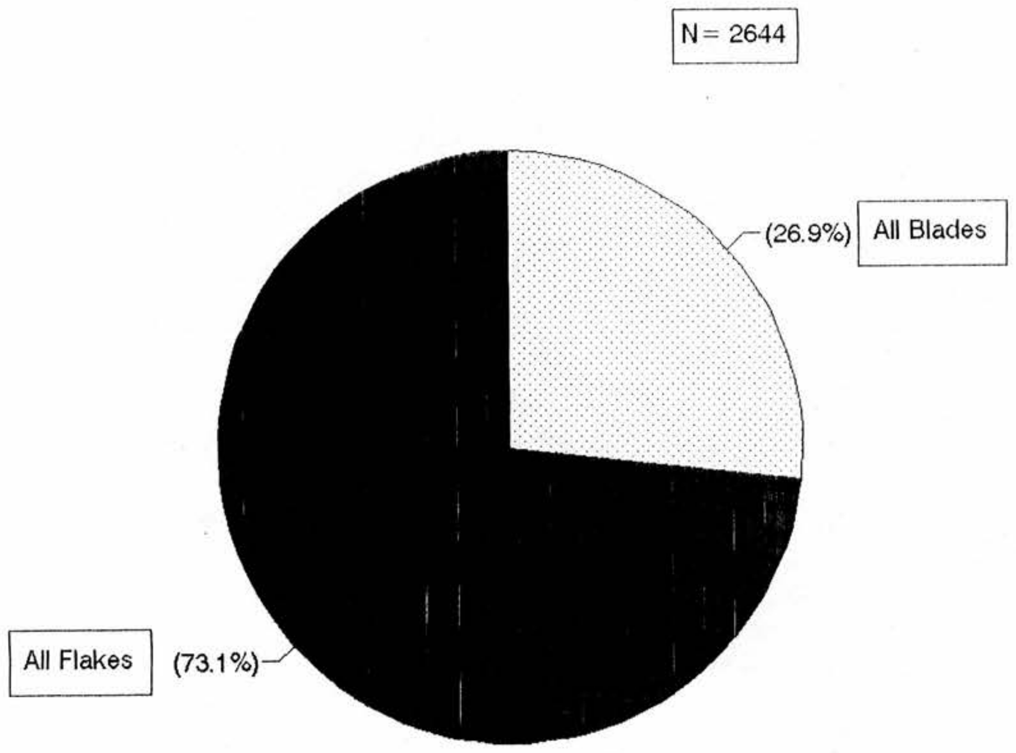


Fig 6.78: J7Ab25a Frequency
distribution of blade-bladelet lengths

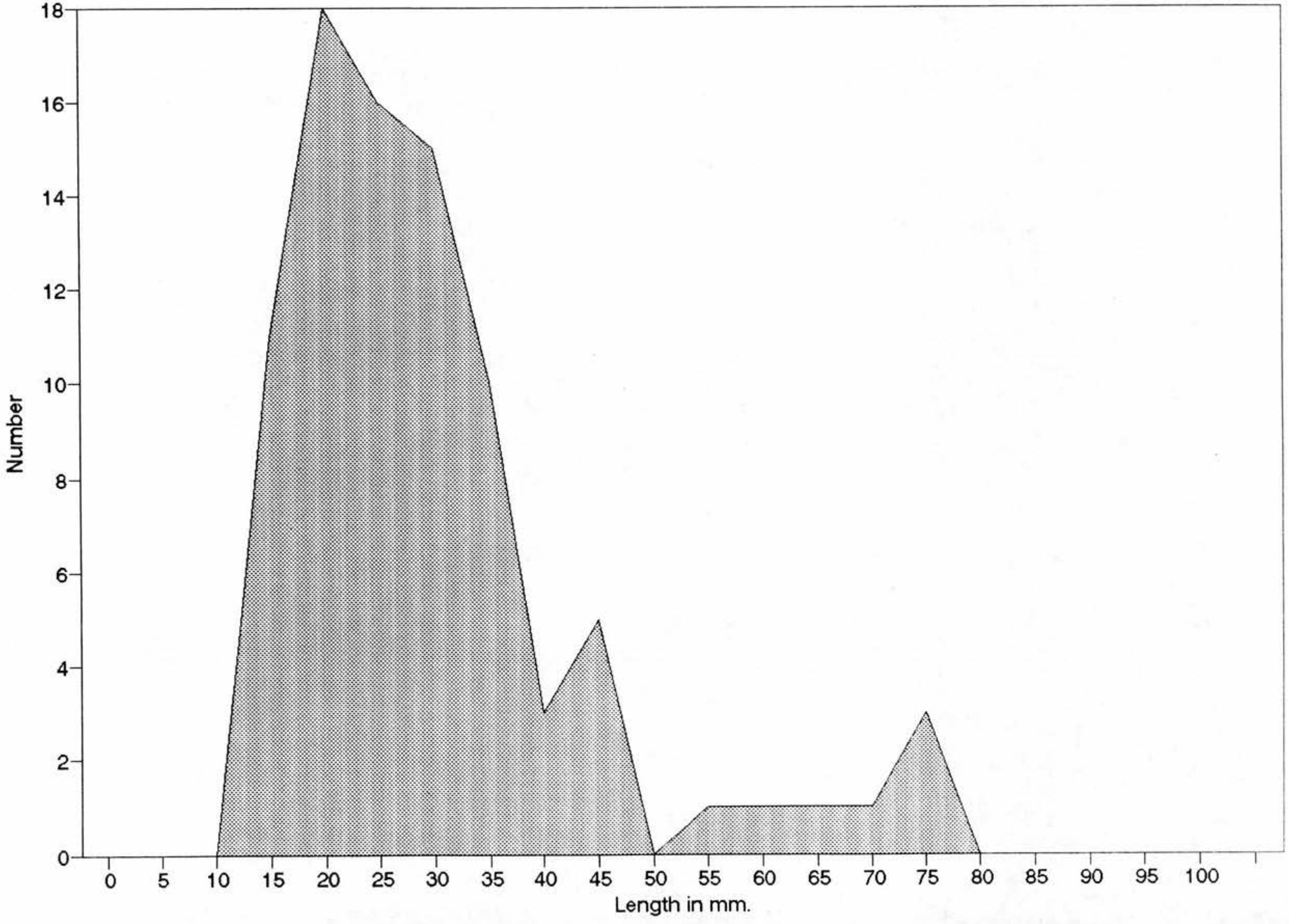


Fig 6.79: J7Ab25a Frequency distribution of blade-bladelet widths

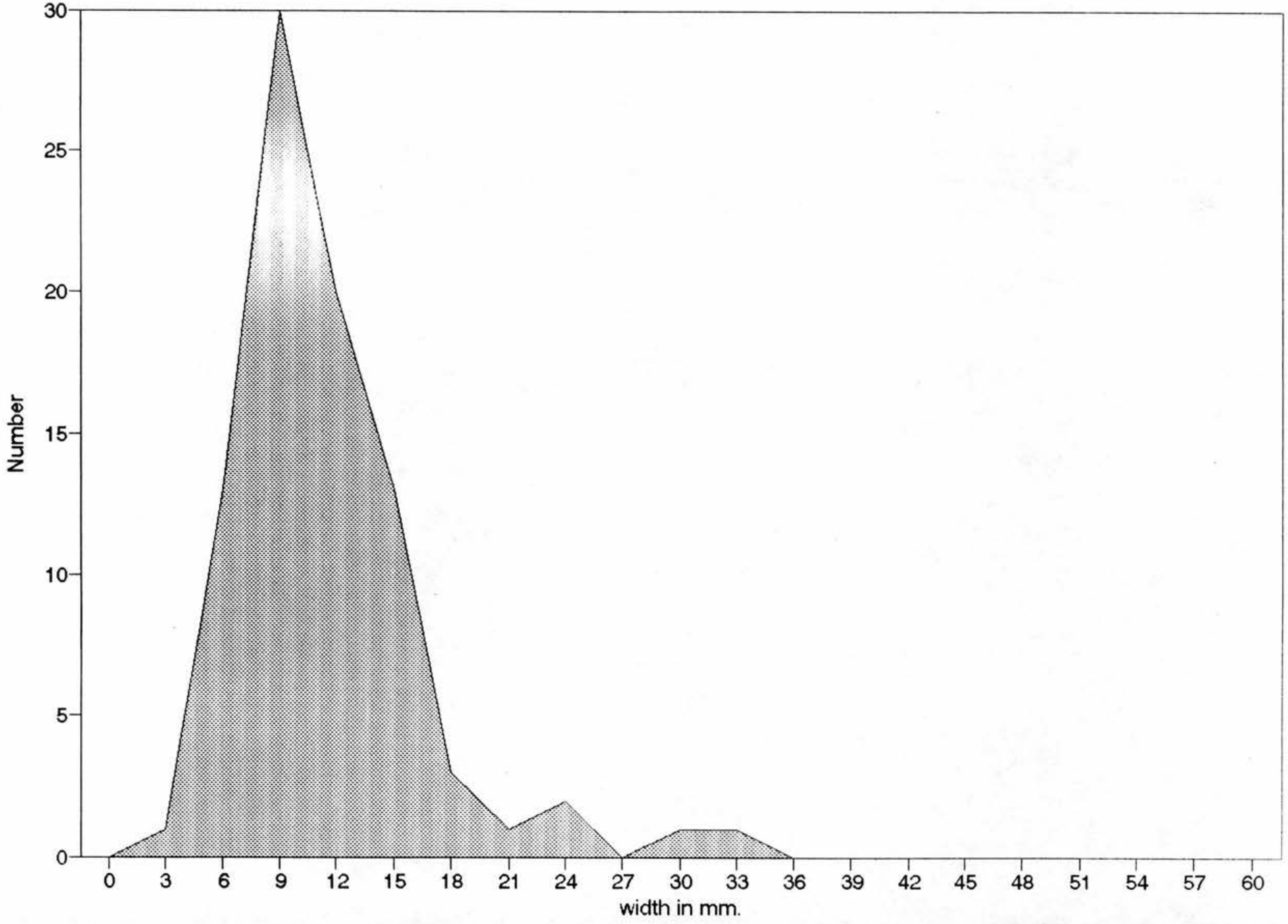


Fig 6.80:J7 B33a Frequency distribution of blade-bladelet lengths

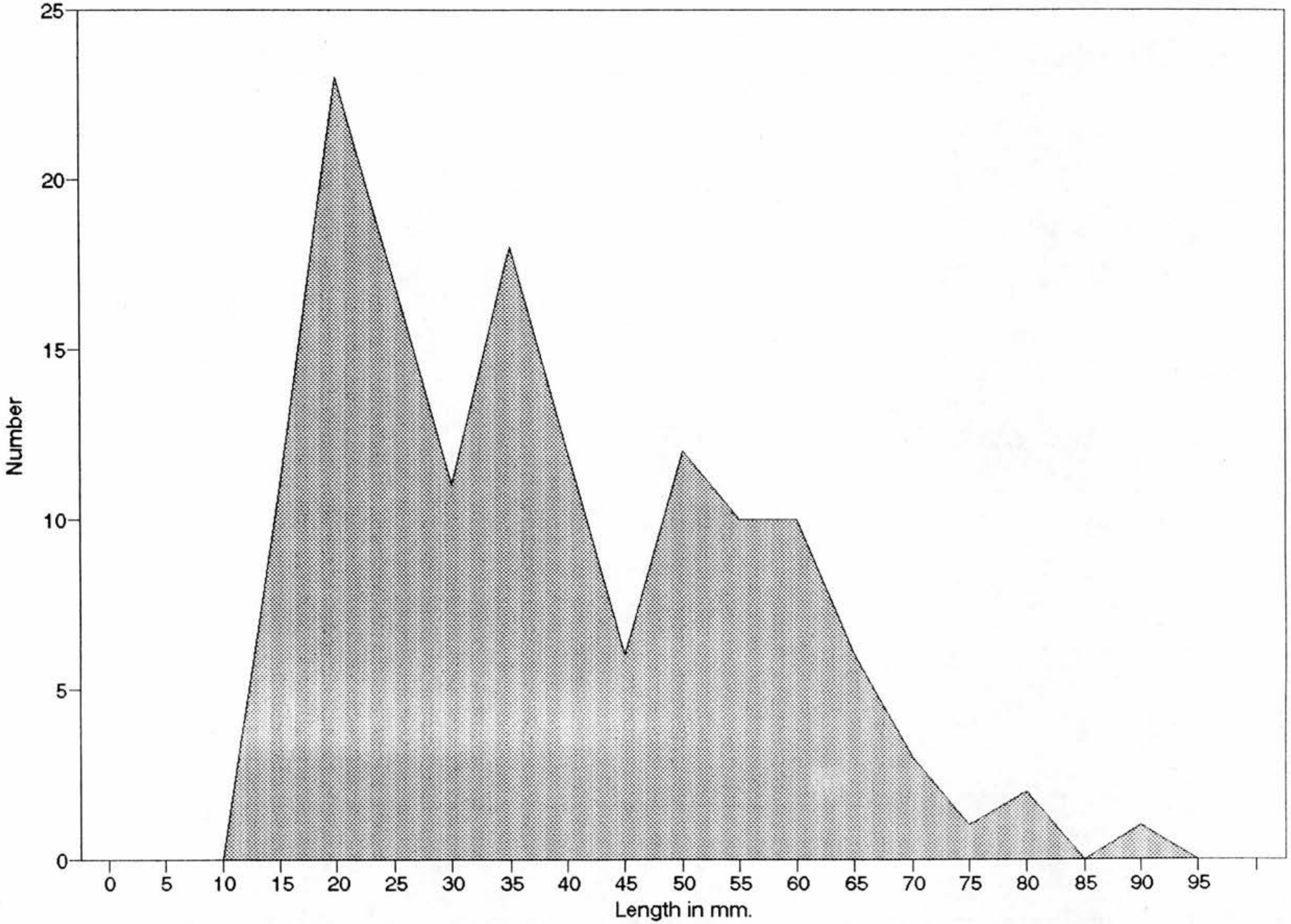


Fig 6.81: J7 B33 Frequency distribution of blade-bladelet widths

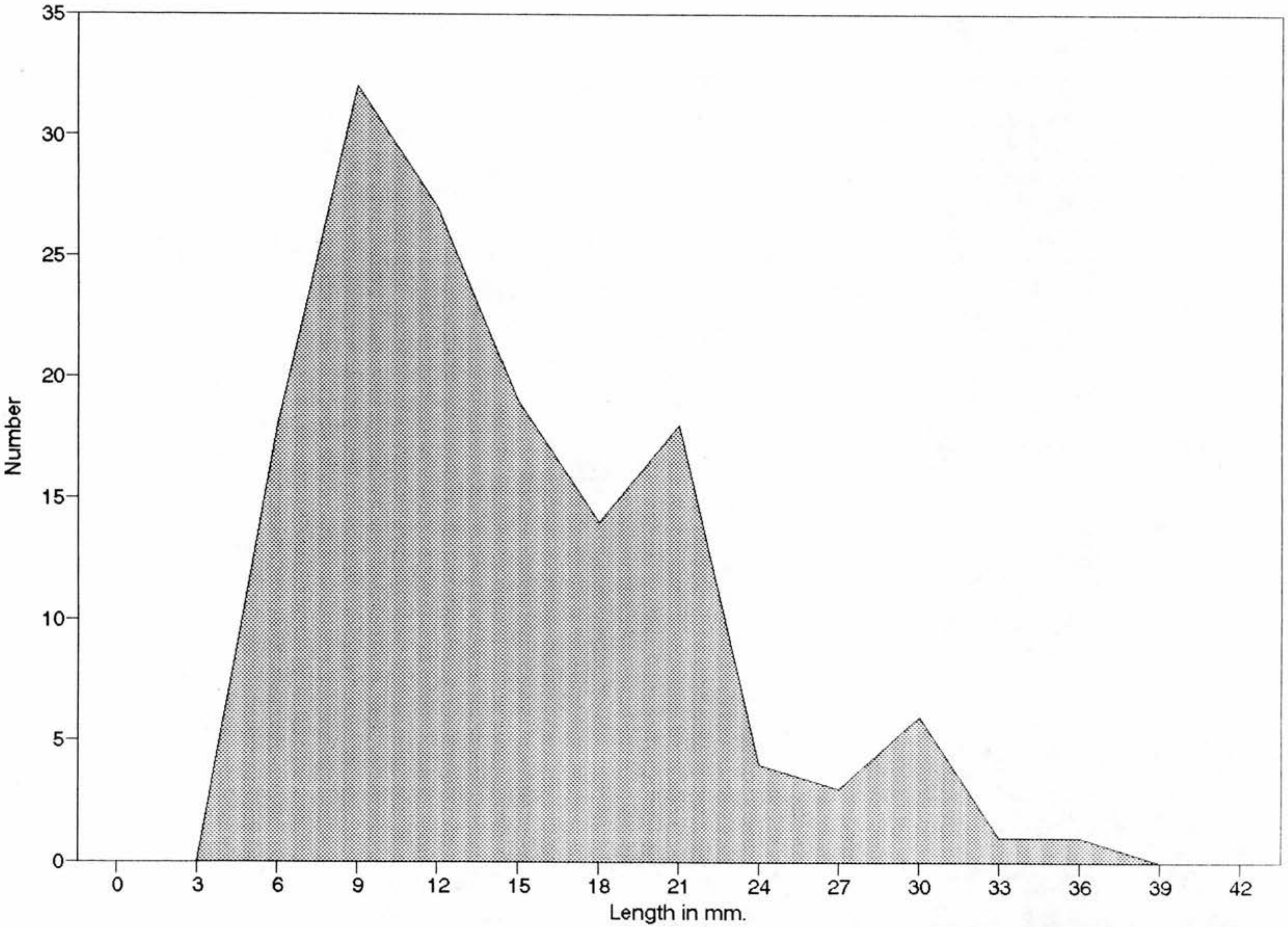


Fig 6.82: J7B11a Frequency distribution of blade-bladelet lengths

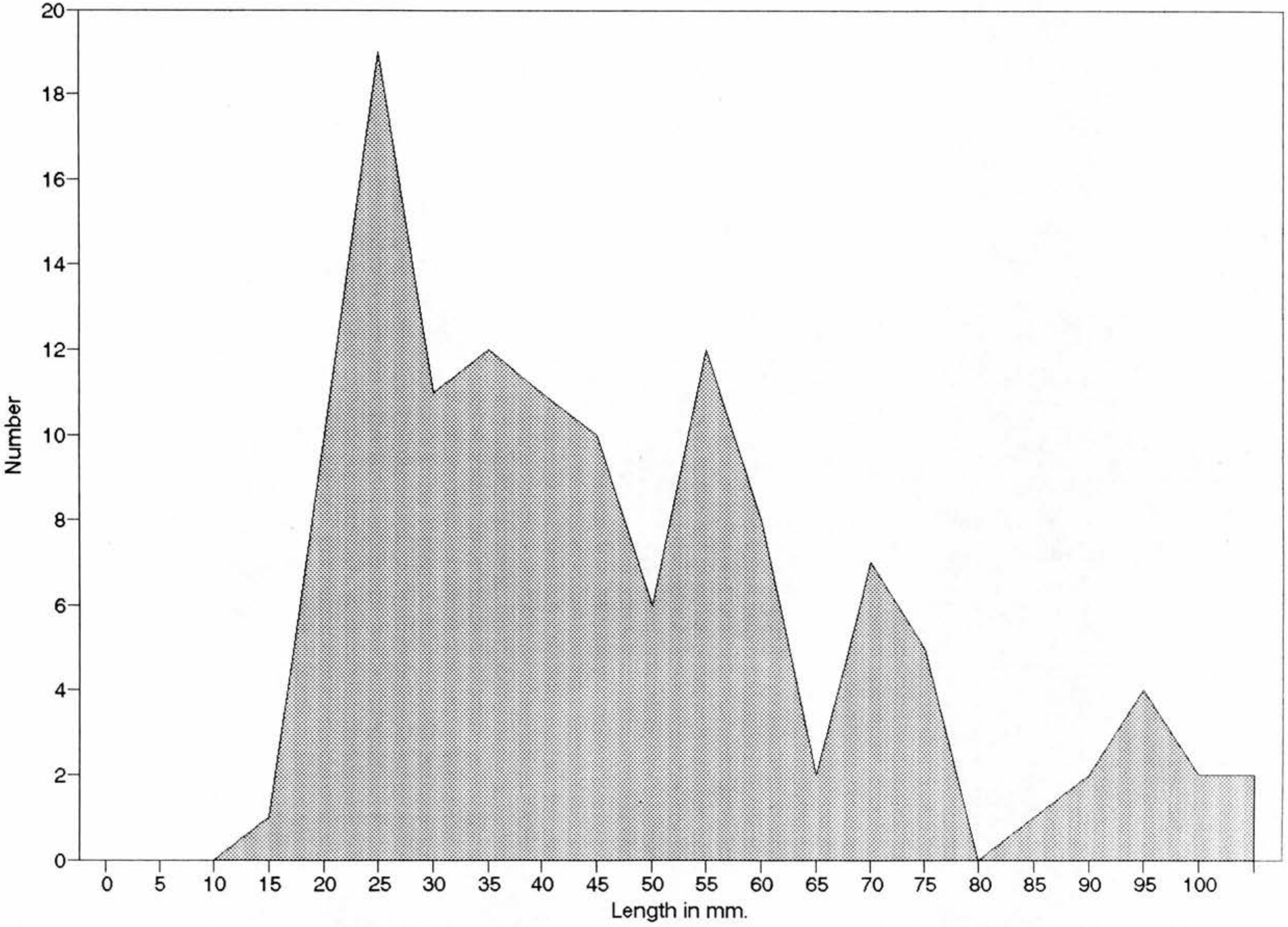


Fig 6.83: J7B11a Frequency distribution of blade-bladelet widths

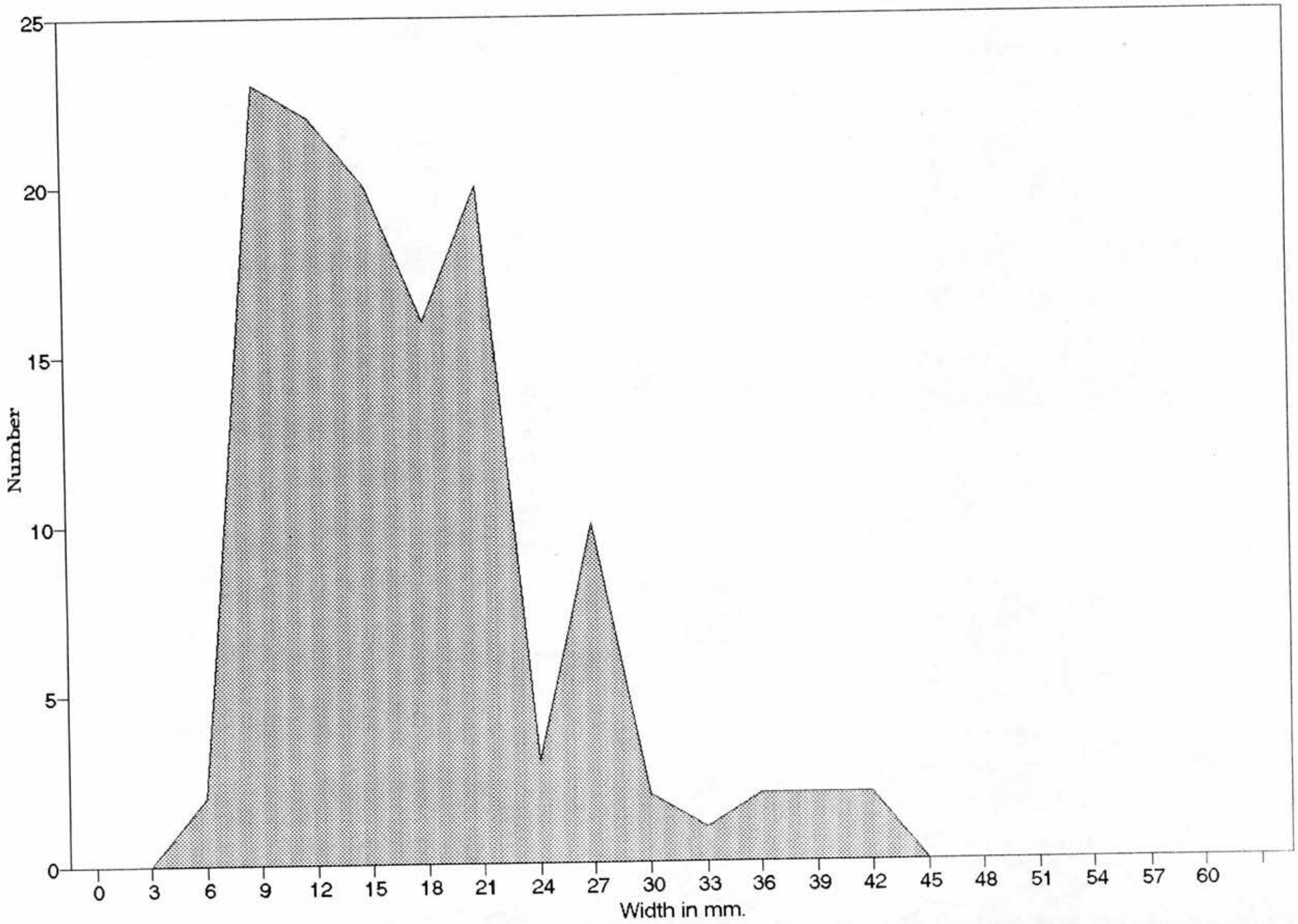


Fig 6.84: J32 Frequency distribution of blade-bladelet lengths

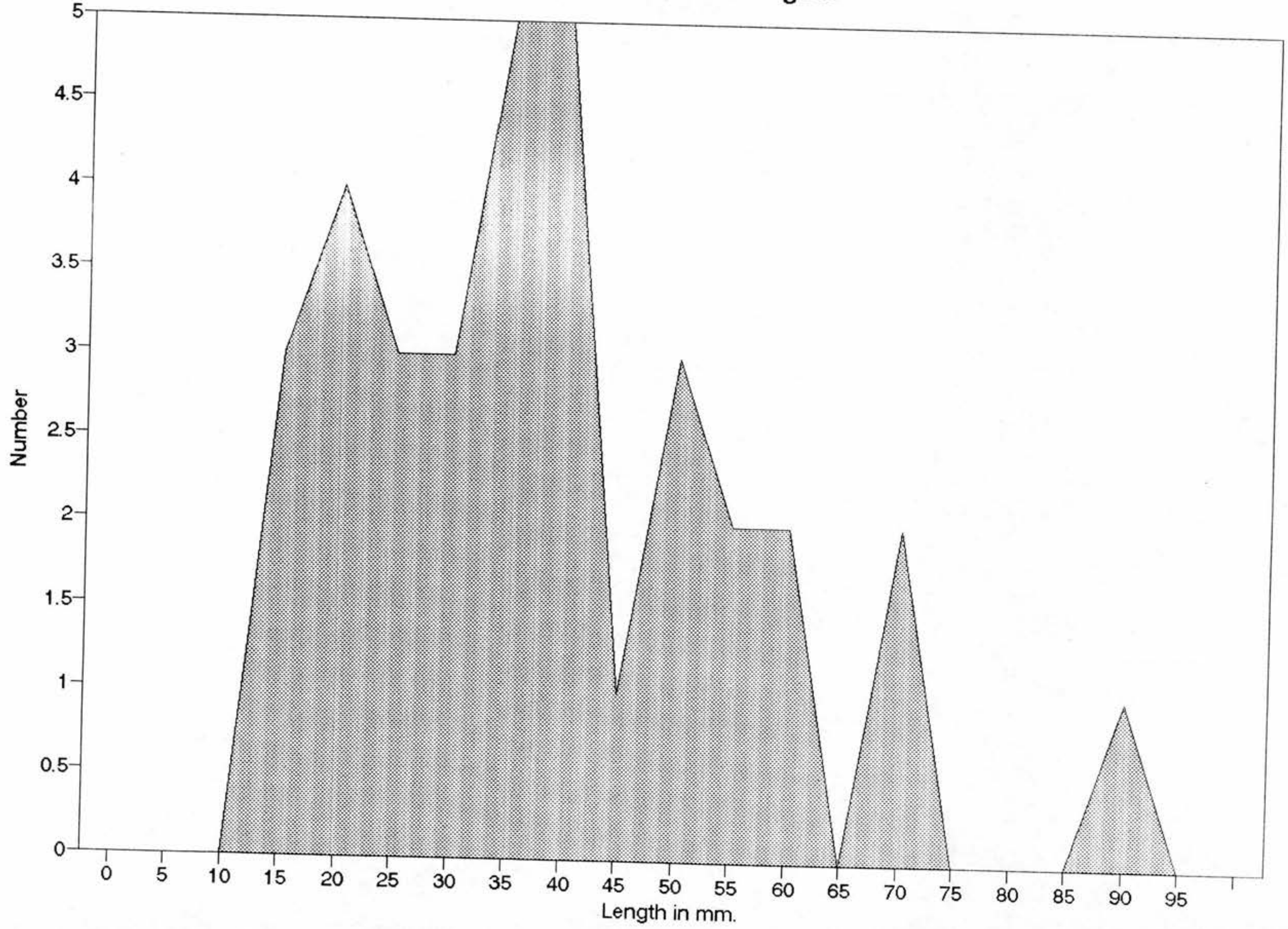


Fig 6.85: J32 Frequency distribution of blade-bladelet widths

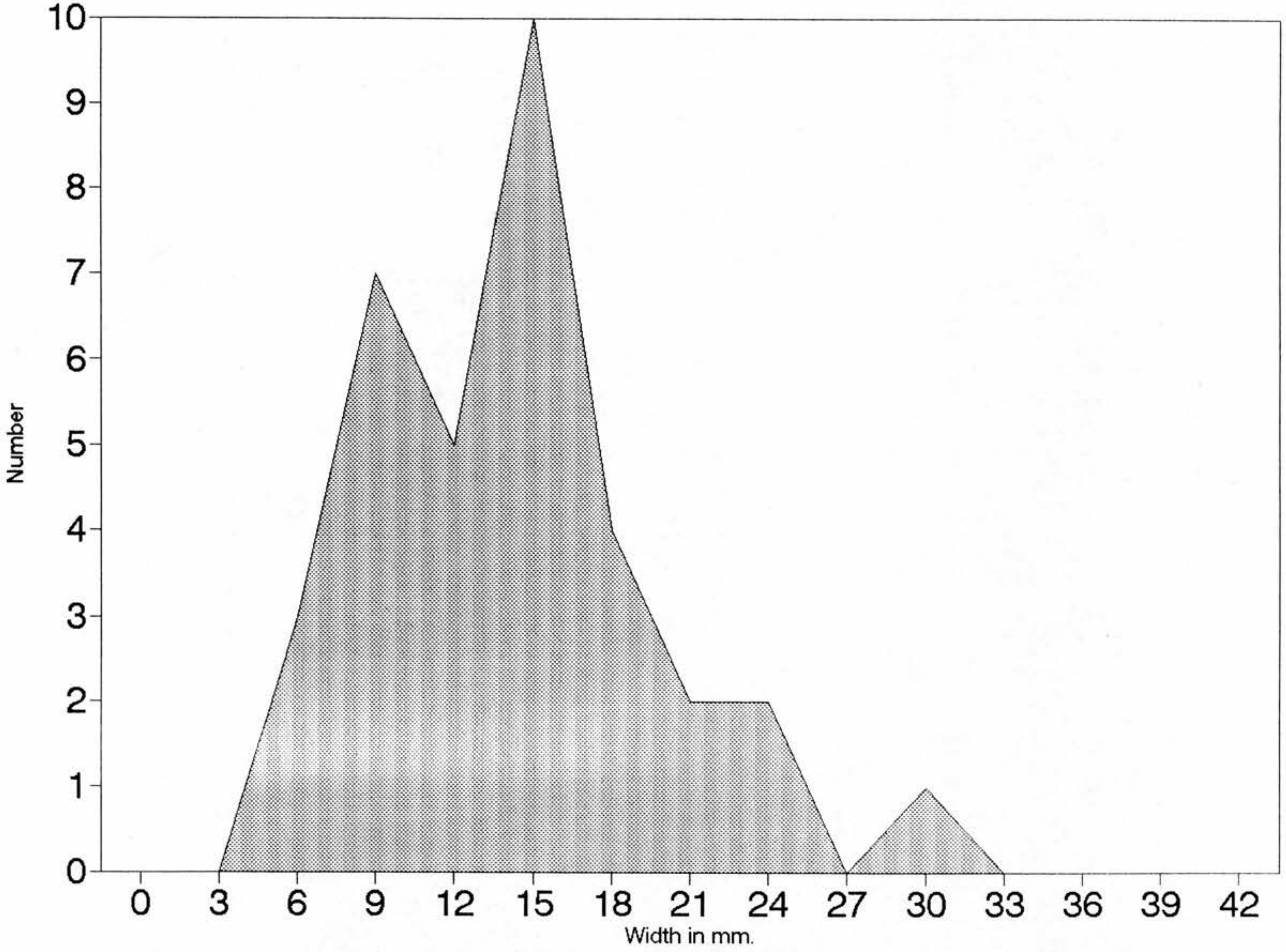


Fig 6.86: J26 Cc17a Frequency distribution of blade-bladelet lengths

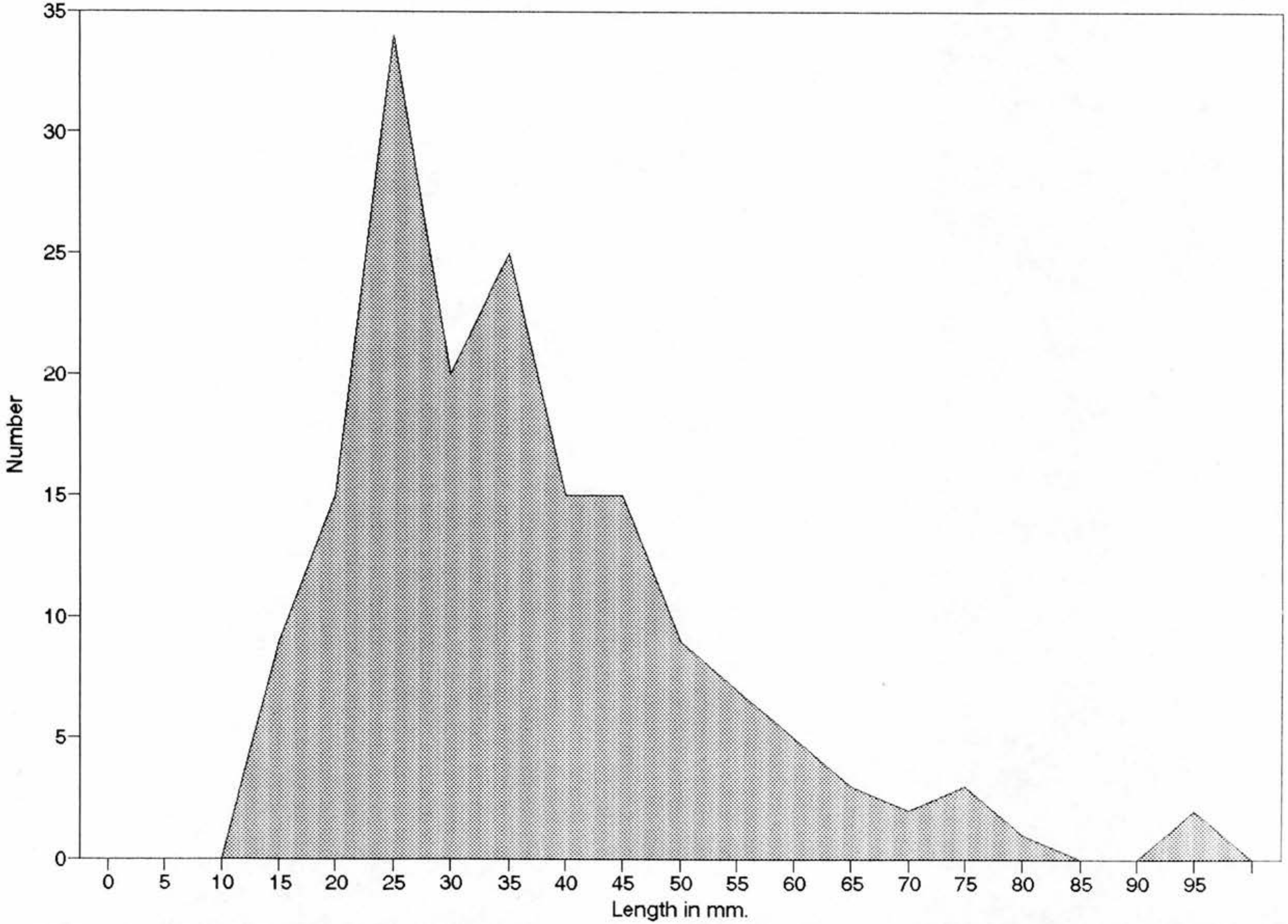


Fig 6.87: J26 Cc17 Frequency distribution of blade-bladelet widths

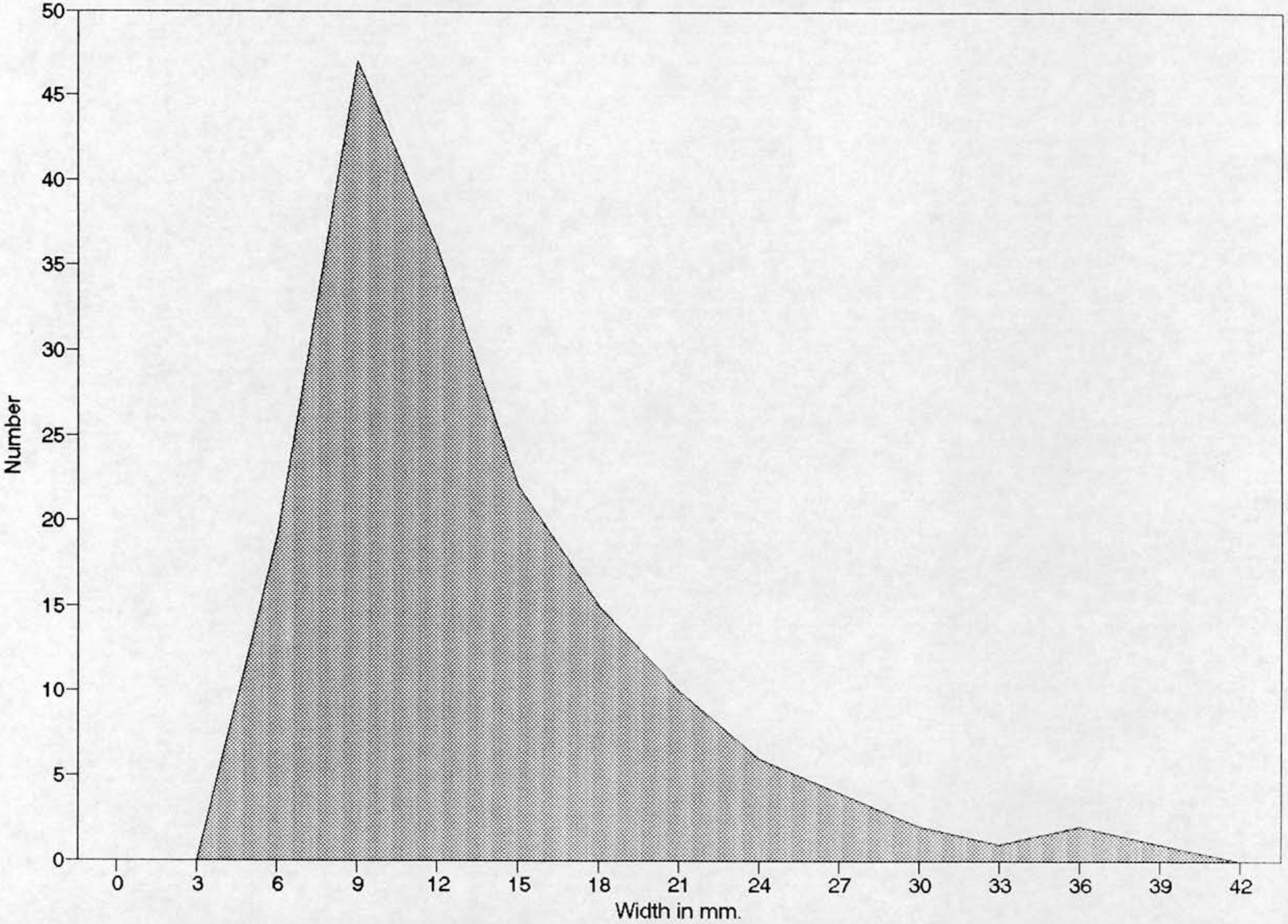


Fig 6.88: A31 Frequency distribution of blade-bladelet lengths

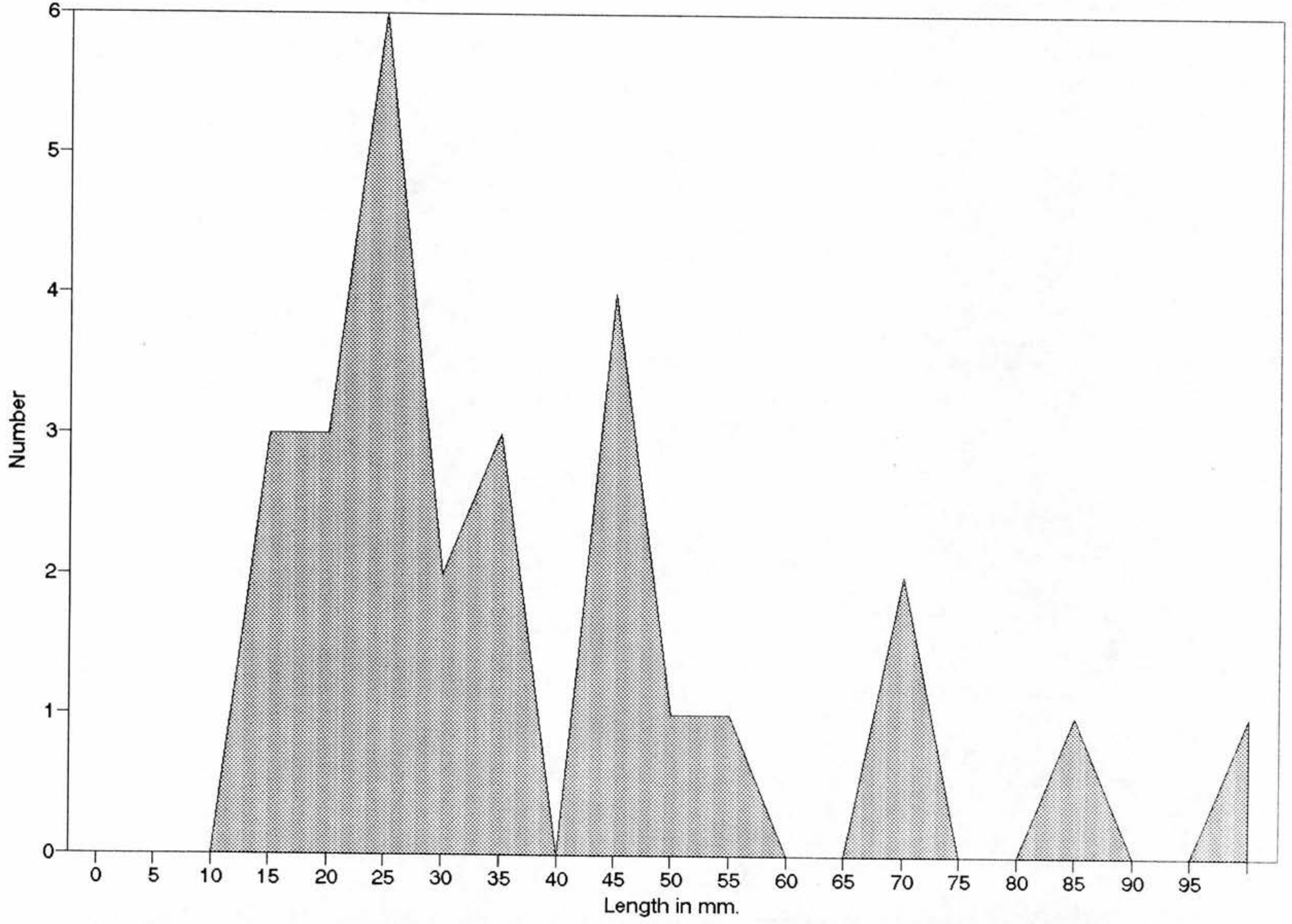


Fig 6.89: A31 Frequency distribution of blade-bladelet widths

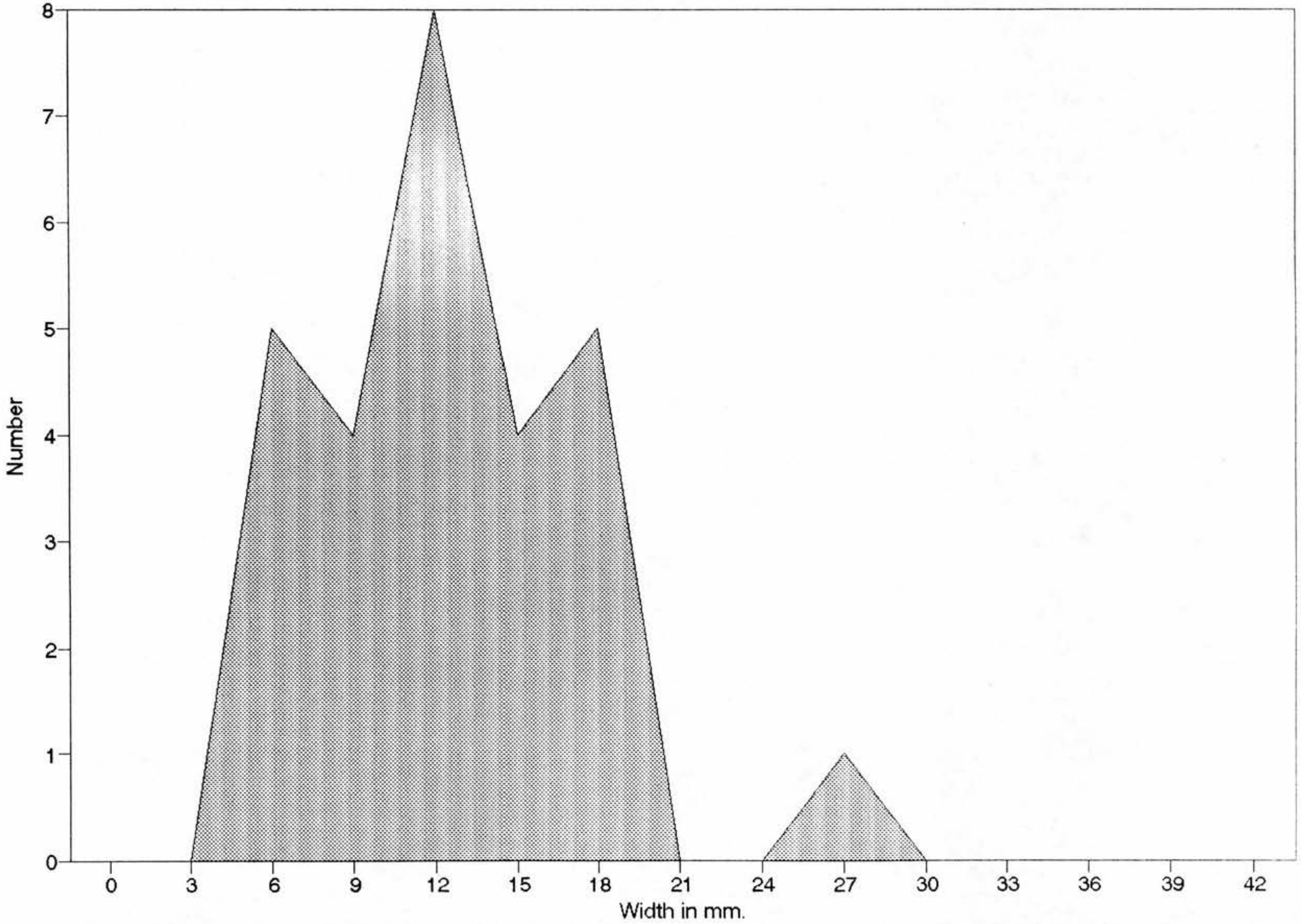


Fig 6.90: J13B77a7 Frequency distribution of blade-bladelet lengths

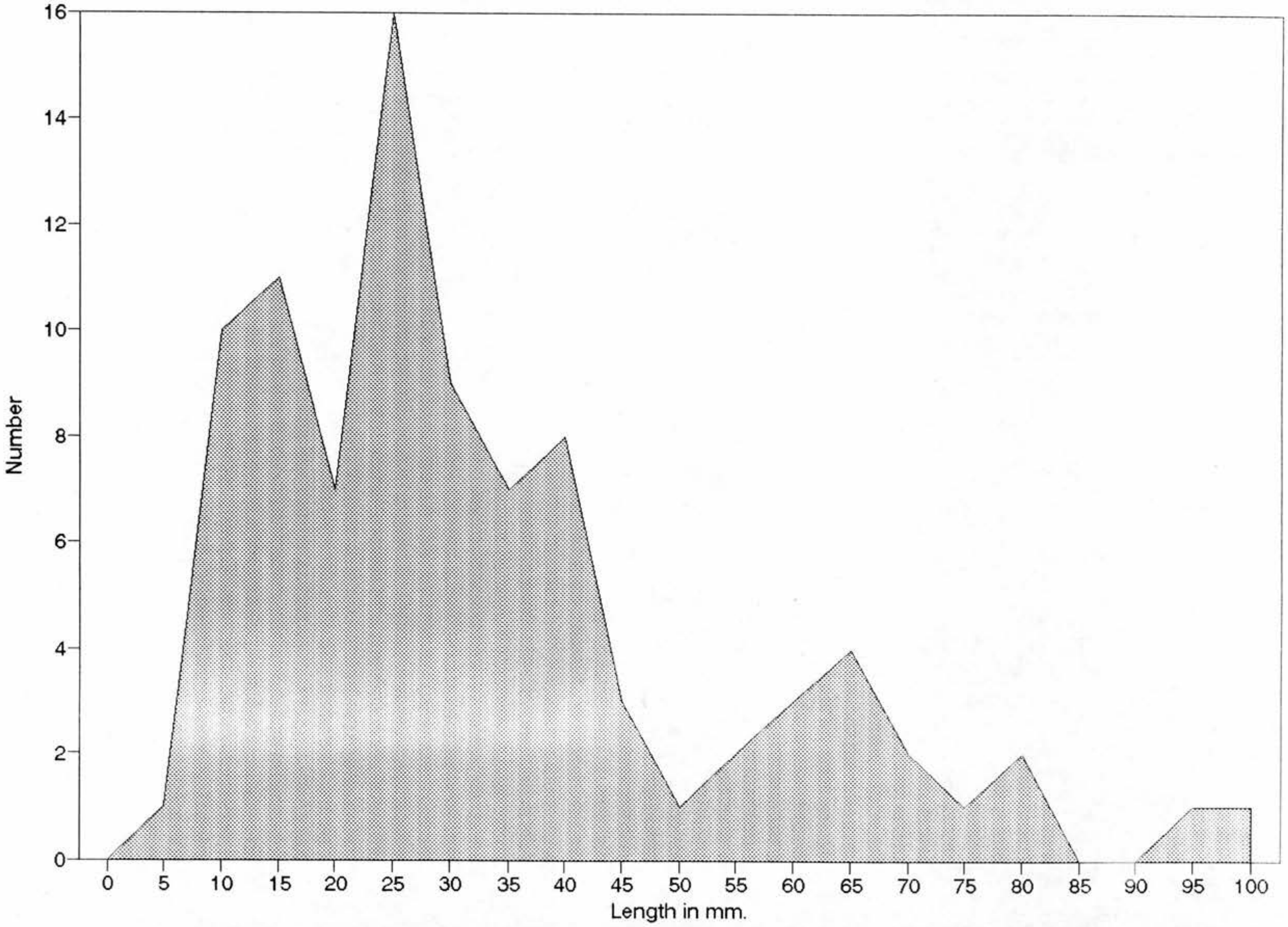


Fig. 6.91 J13B77a7 Frequency distribution of blade-bladelet widths

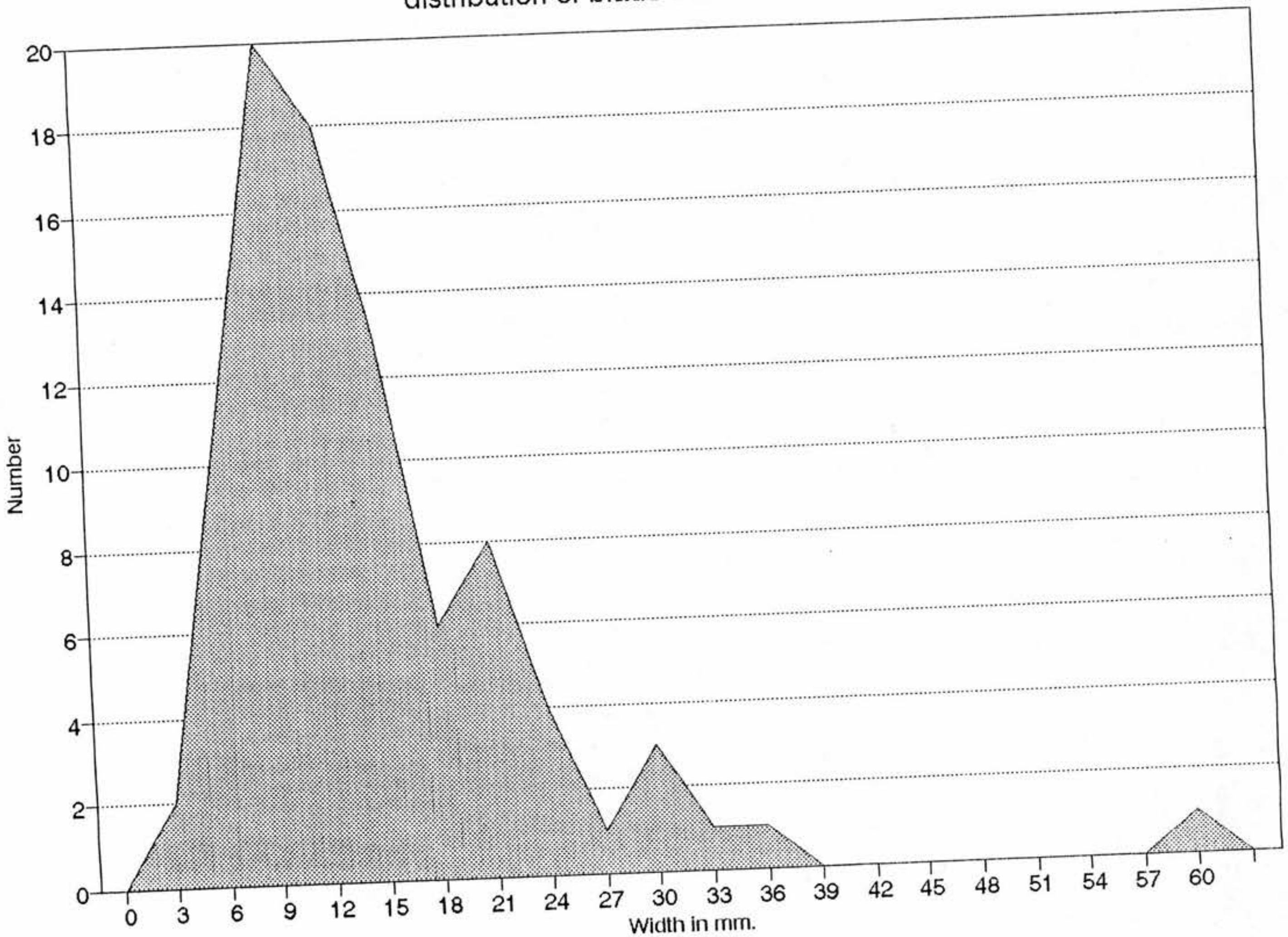


Fig 6.92: J13 B7c Frequency
distribution of blade-bladelet lengths

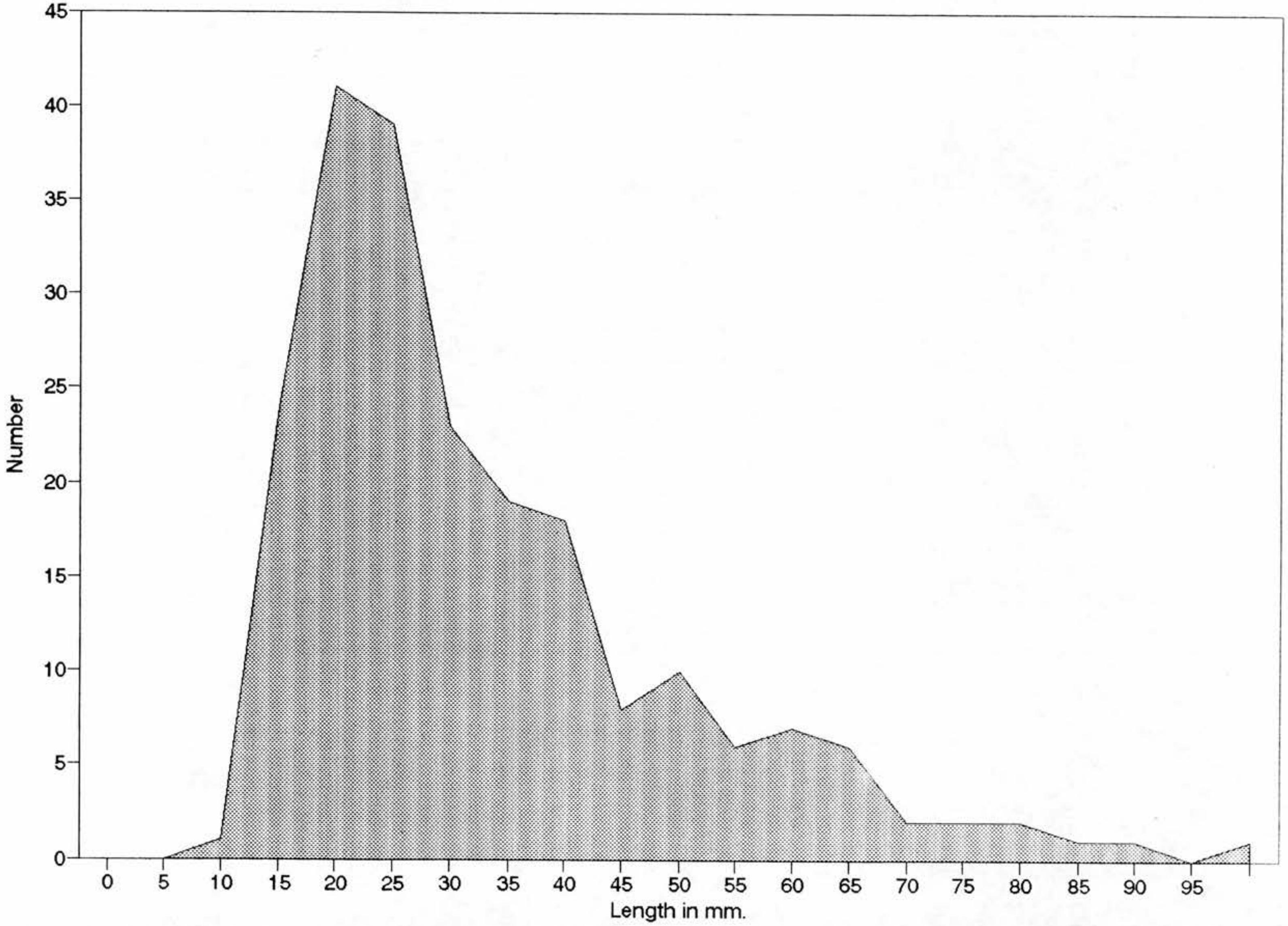


Fig 6.93: J13 B7 Frequency distribution
of blade-bladelet widths

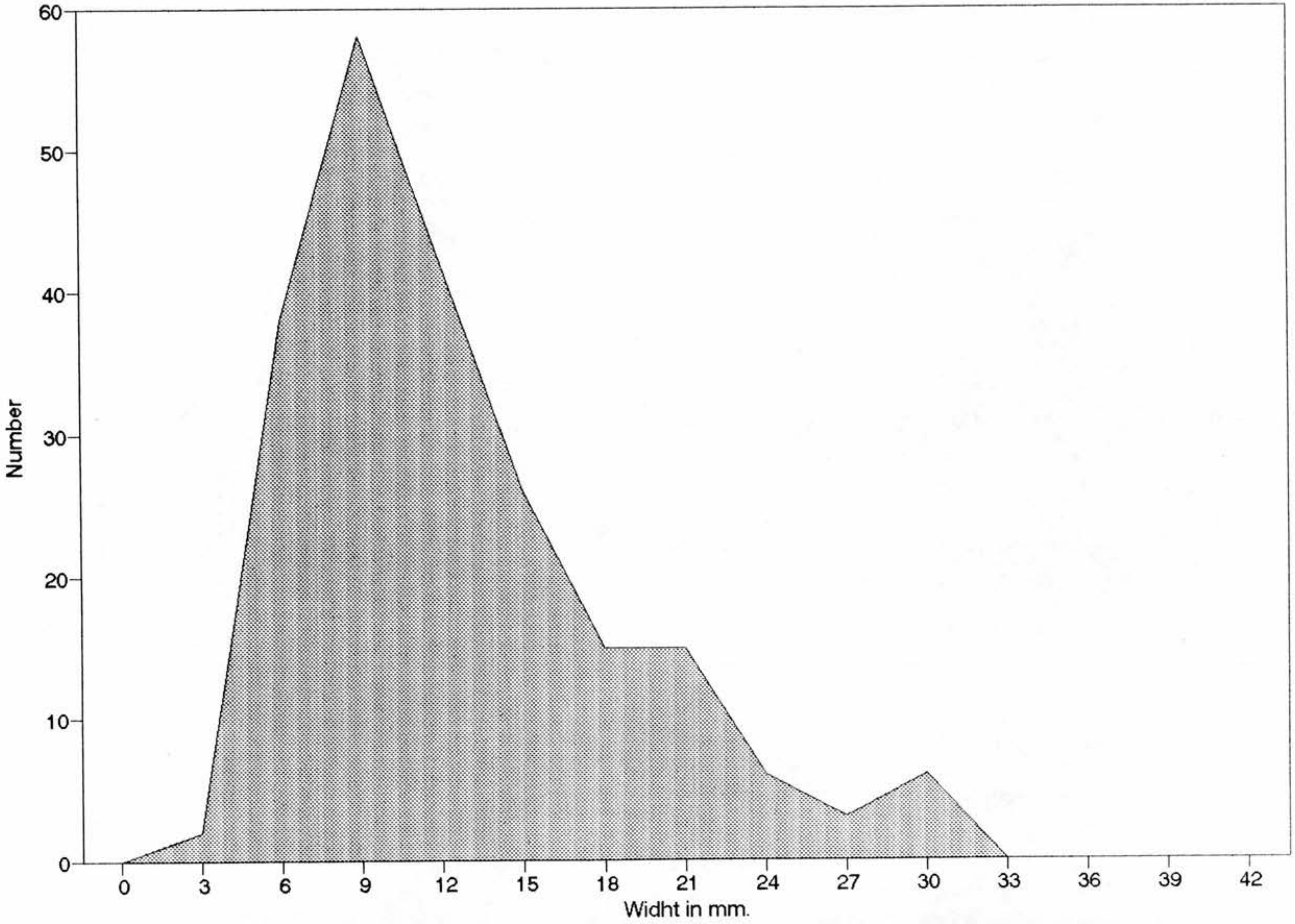


Fig. 6.94 J25 Blades frequency distribution of lengths

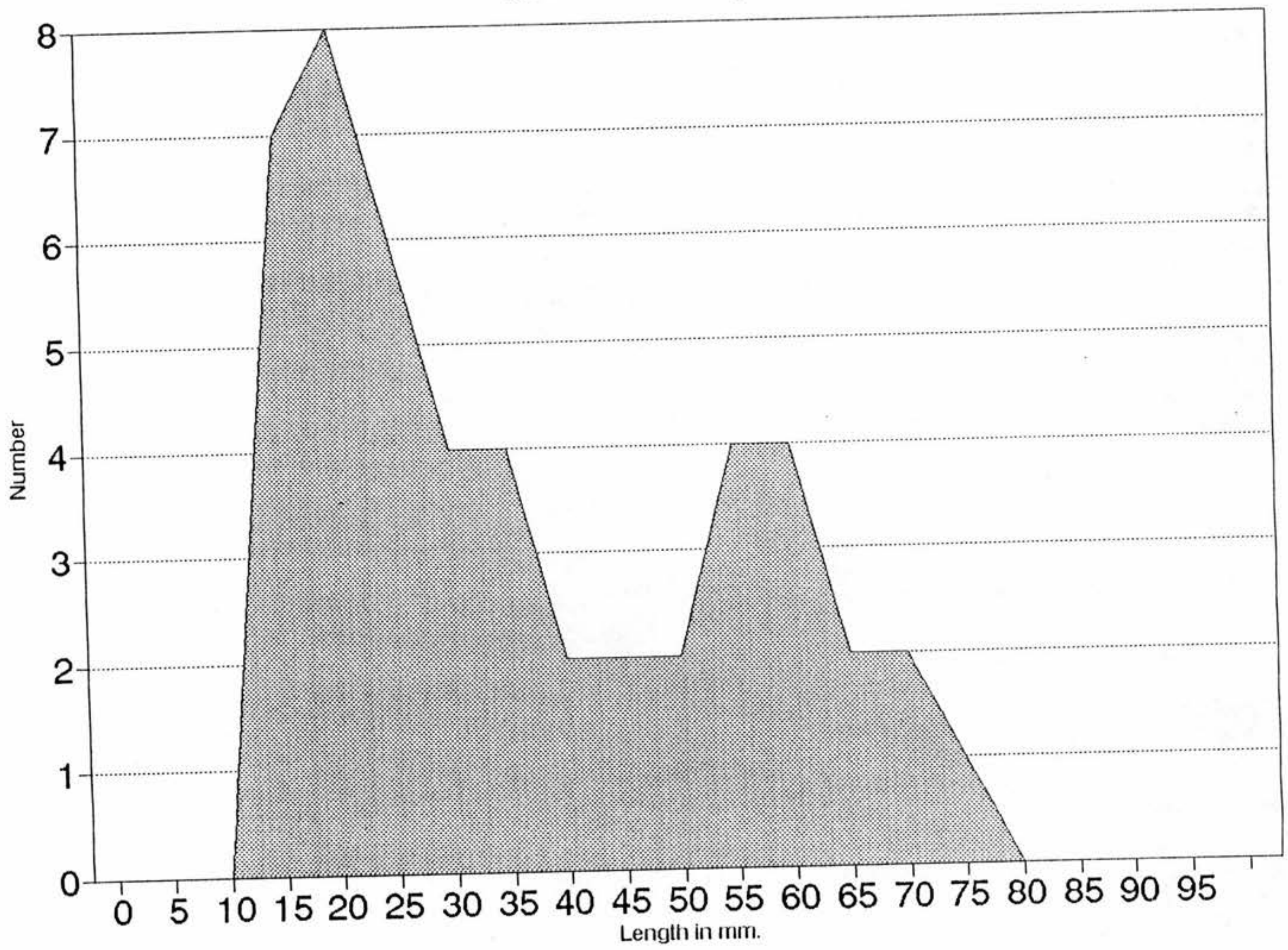


Fig 6.95: J25 Frequency distribution of blade-bladelet widths

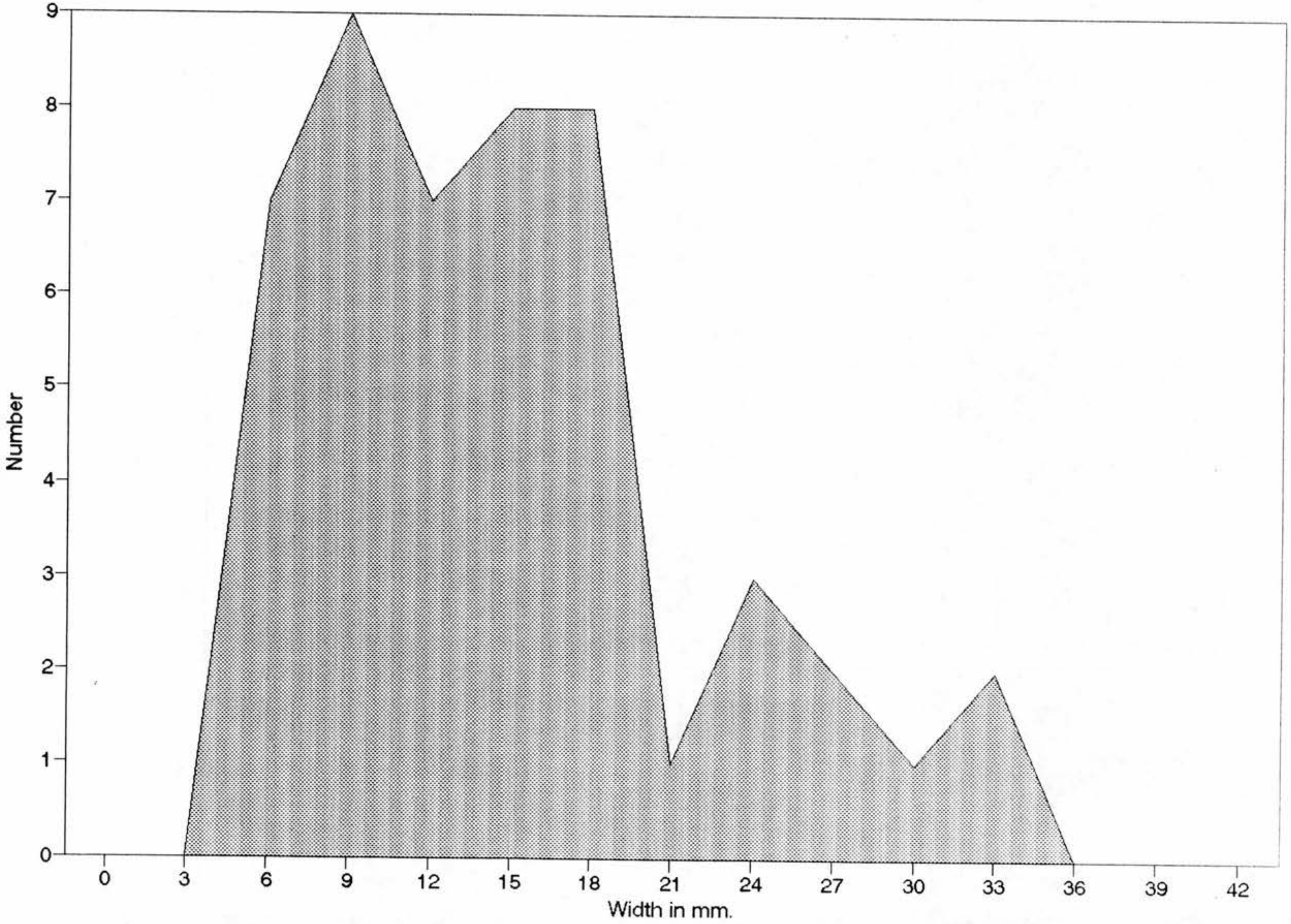


Fig6.96:J7 Ab25a Frequency distribution of blade-bladelet thicknesses

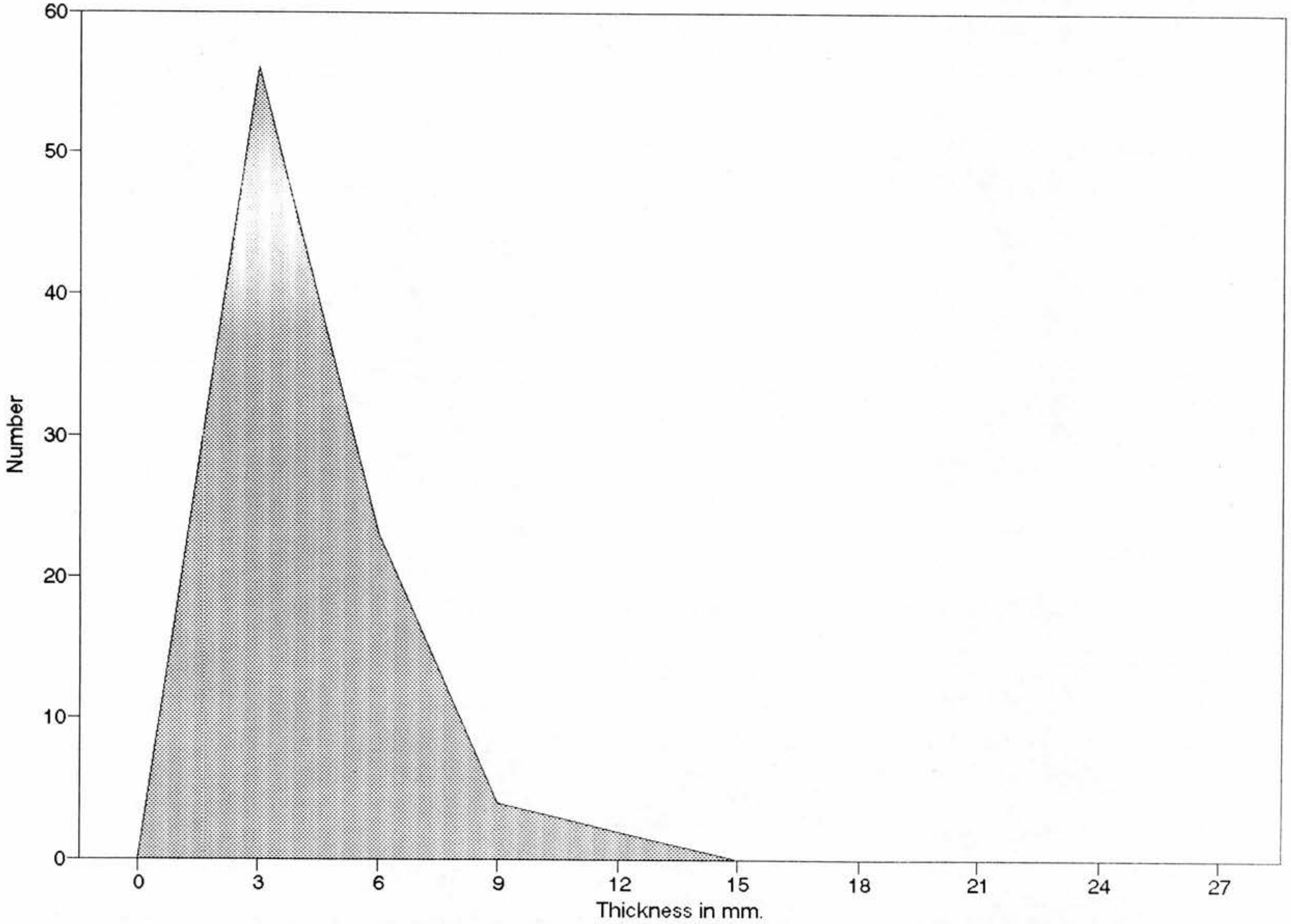


Fig 6.97: J7 B33 Frequency distribution of blade-bladelet thicknesses

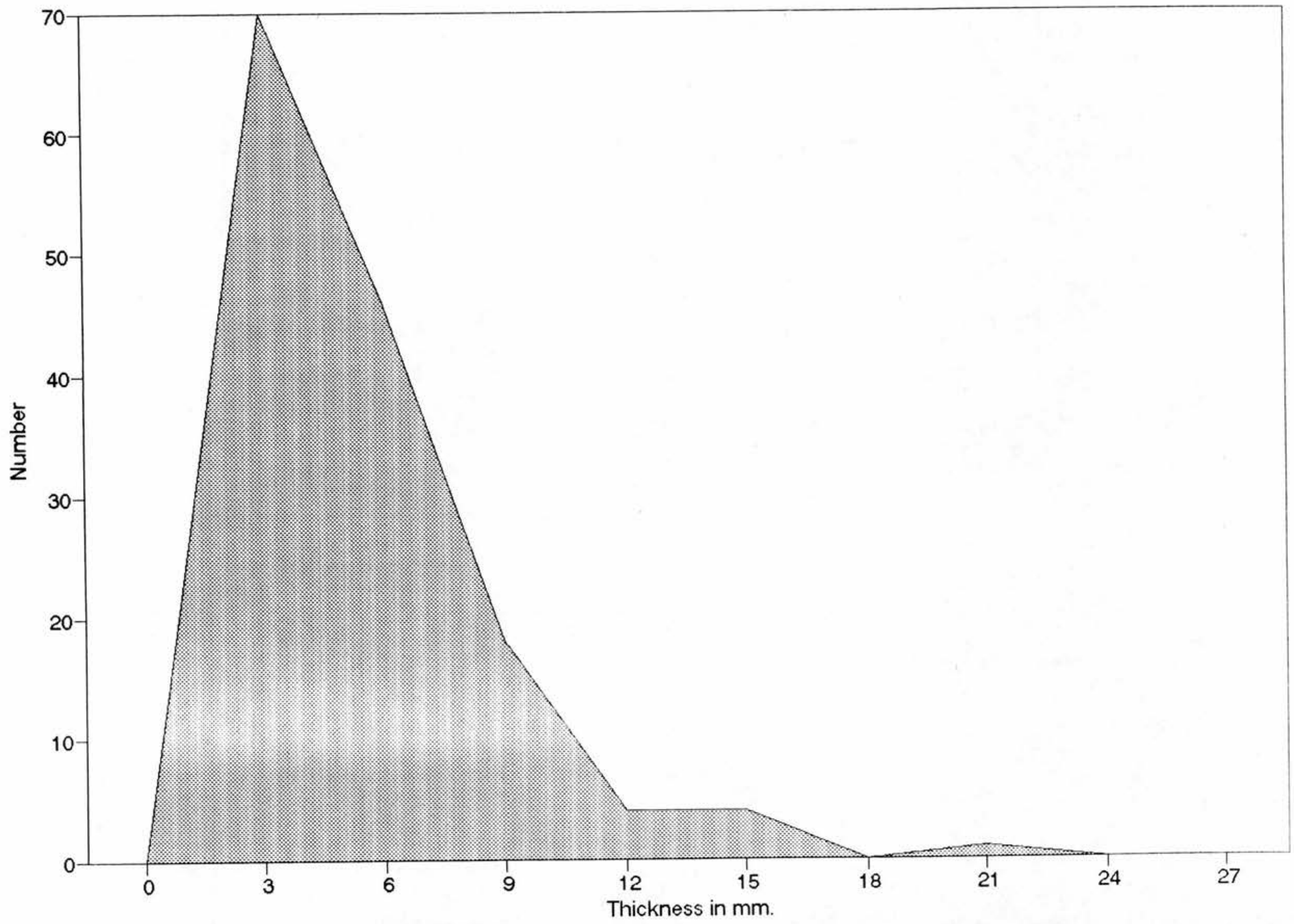


Fig6.98:J26 Cc17 Frequency distribution of blade-bladelet thicknesses

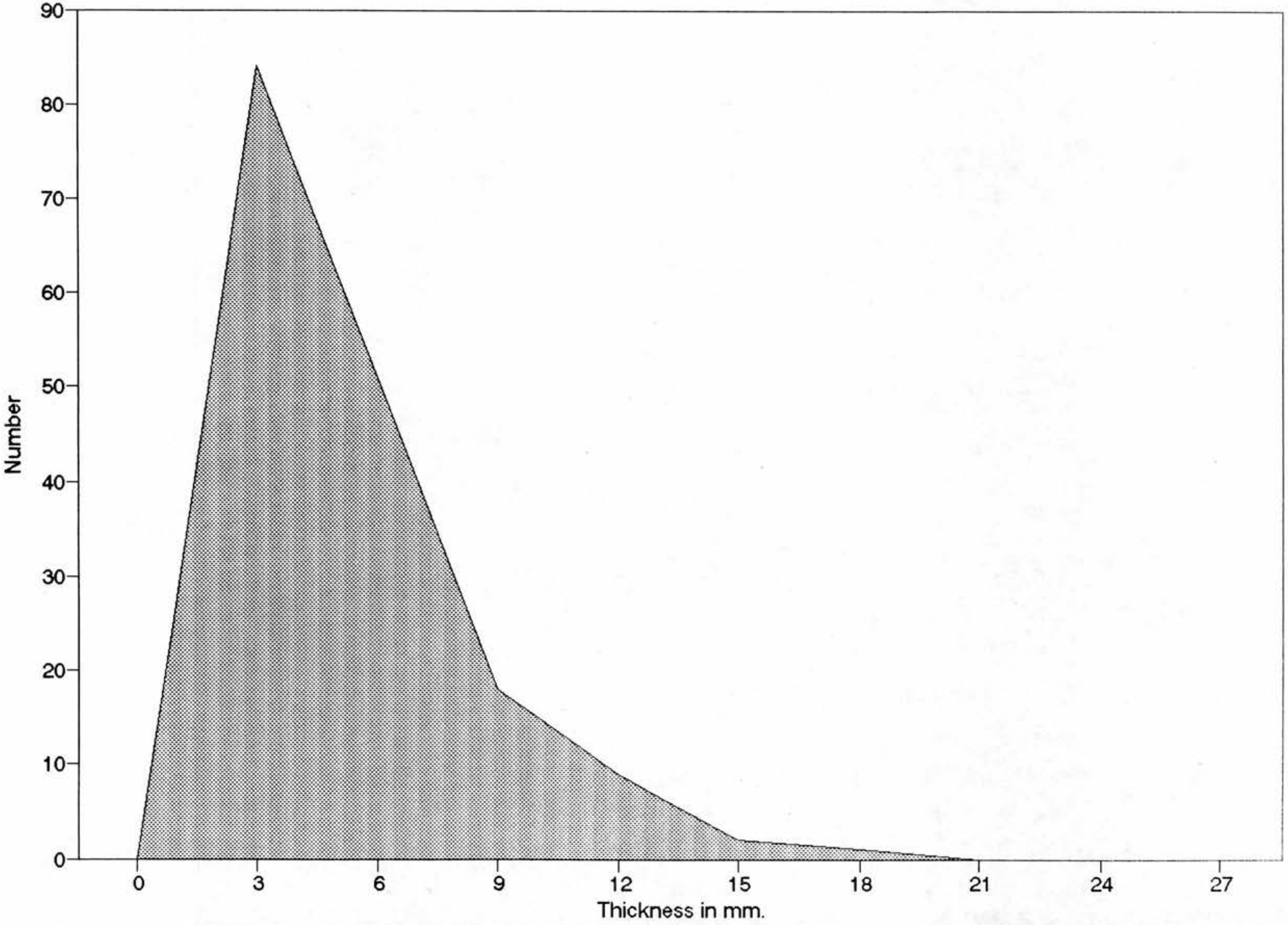


Fig 6.99: J13 B7 Frequency distribution of blade-bladelet thicknesses

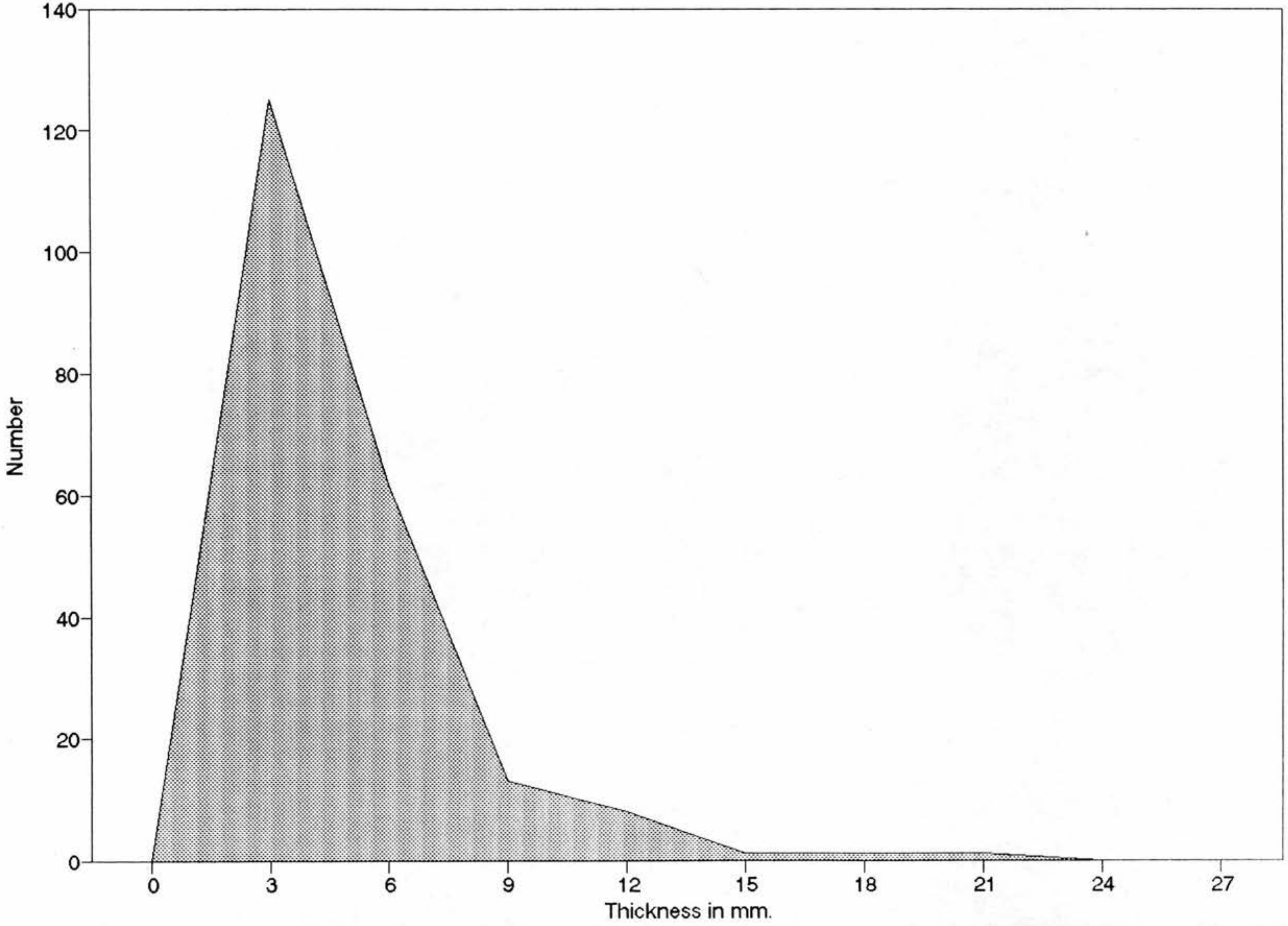


Fig 6.100: J32 Frequency distribution of blade-bladelet thicknesses

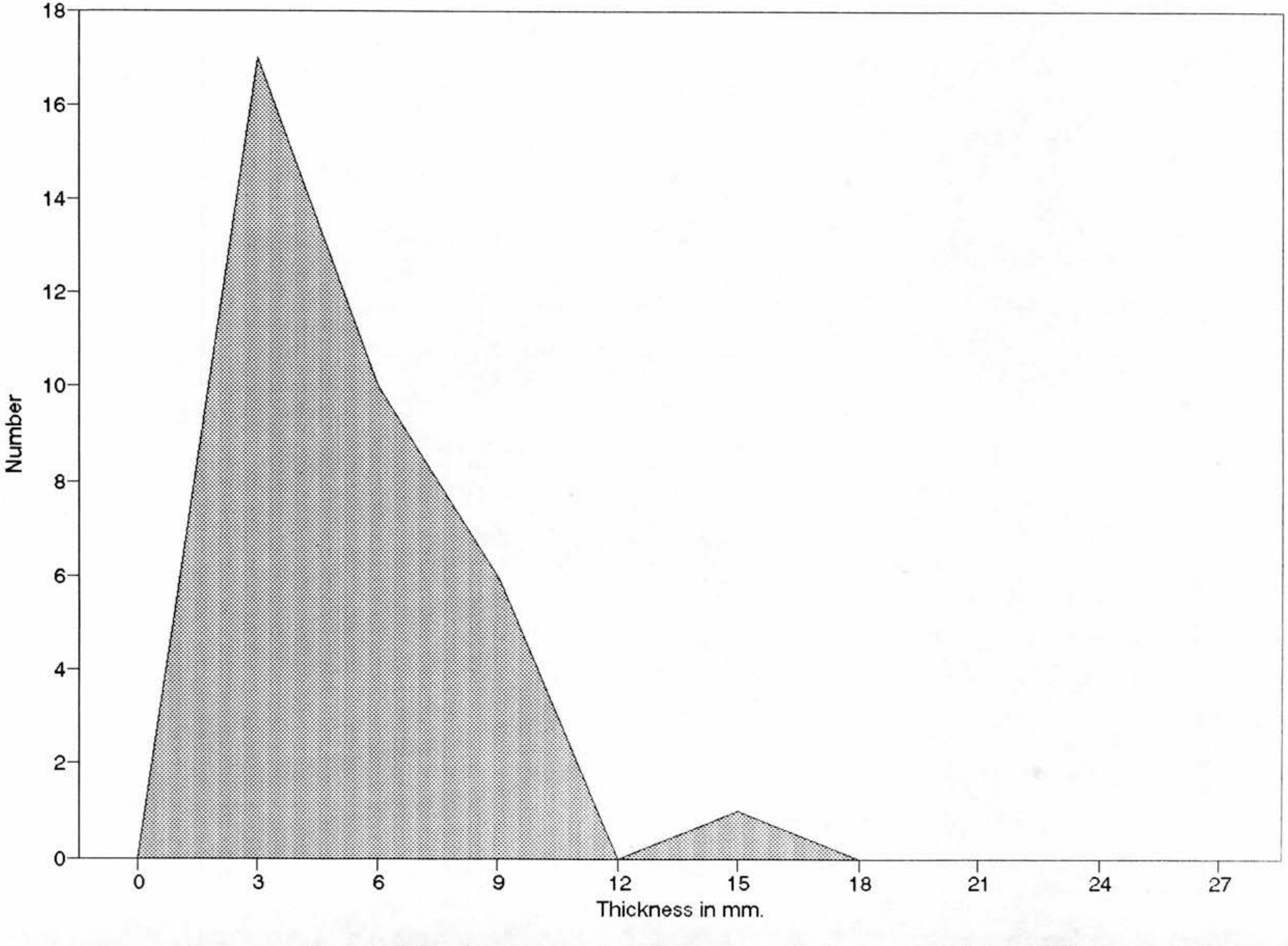


Fig 6.101: A31 Frequency distribution of blade-bladelet thicknesses

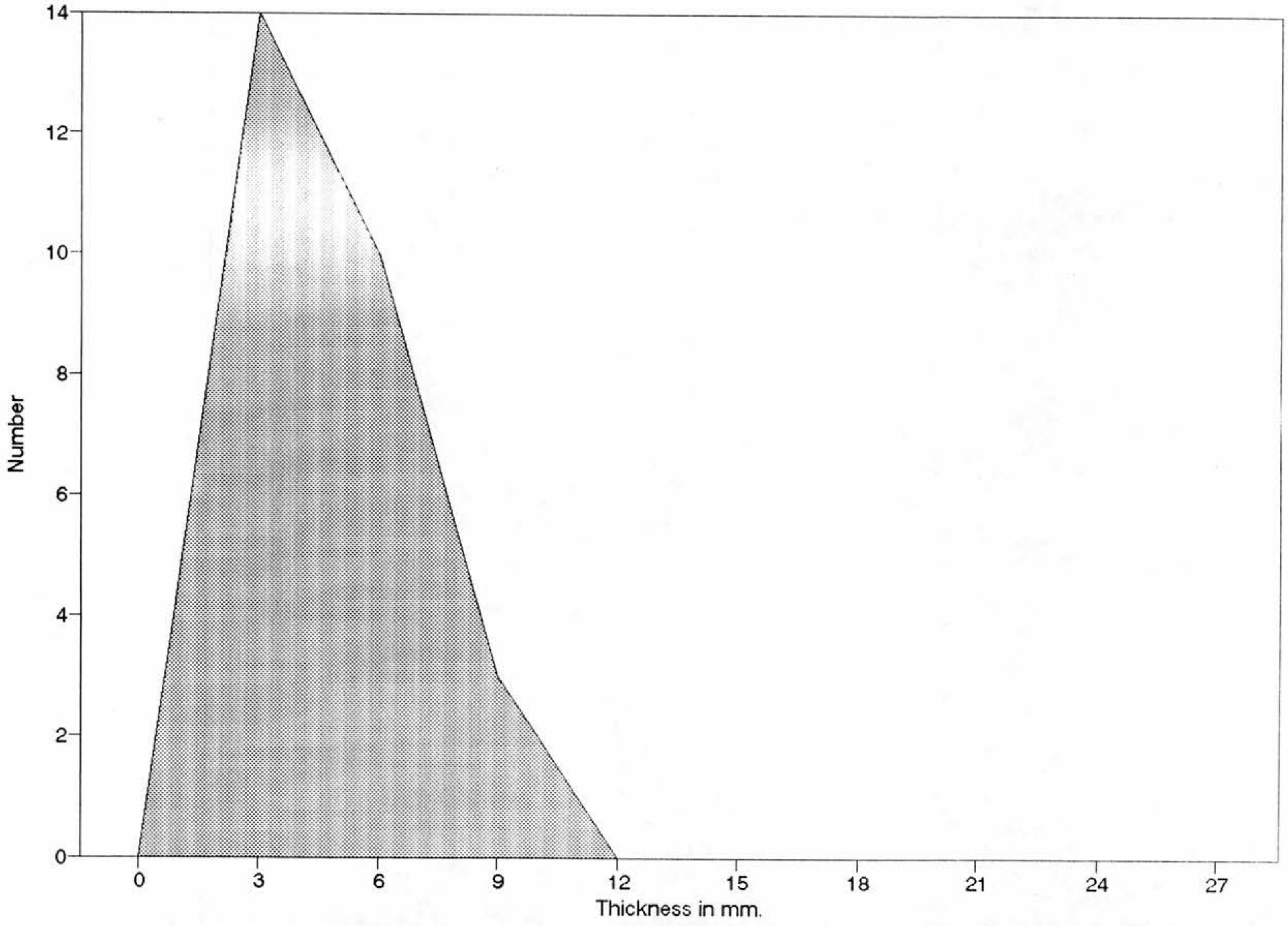


Fig 6.102: J13 B77 Frequency distribution of blade/let thicknesses

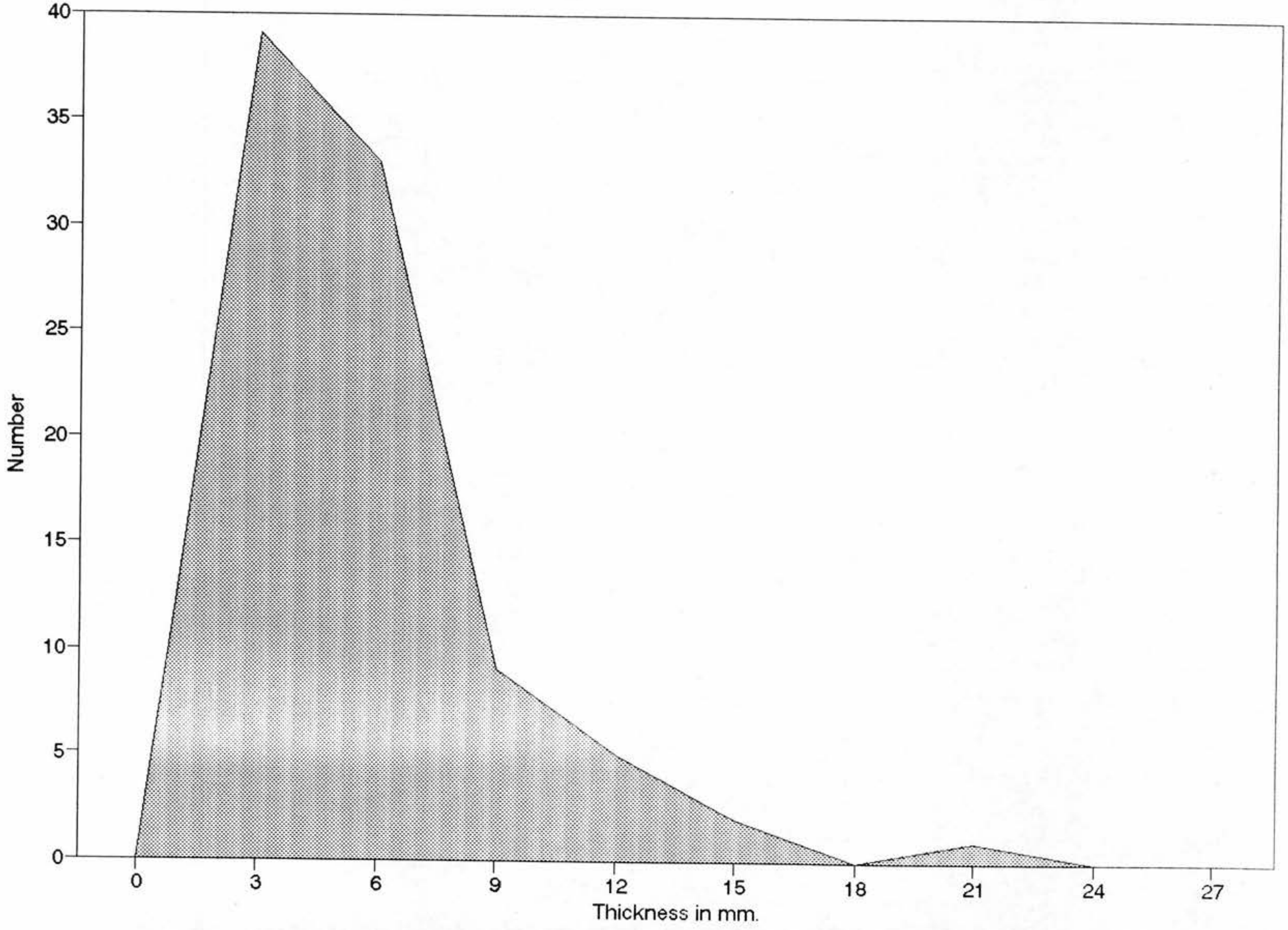


Fig 6.103: J25 Frequency distribution of blade-bladelet thicknesses

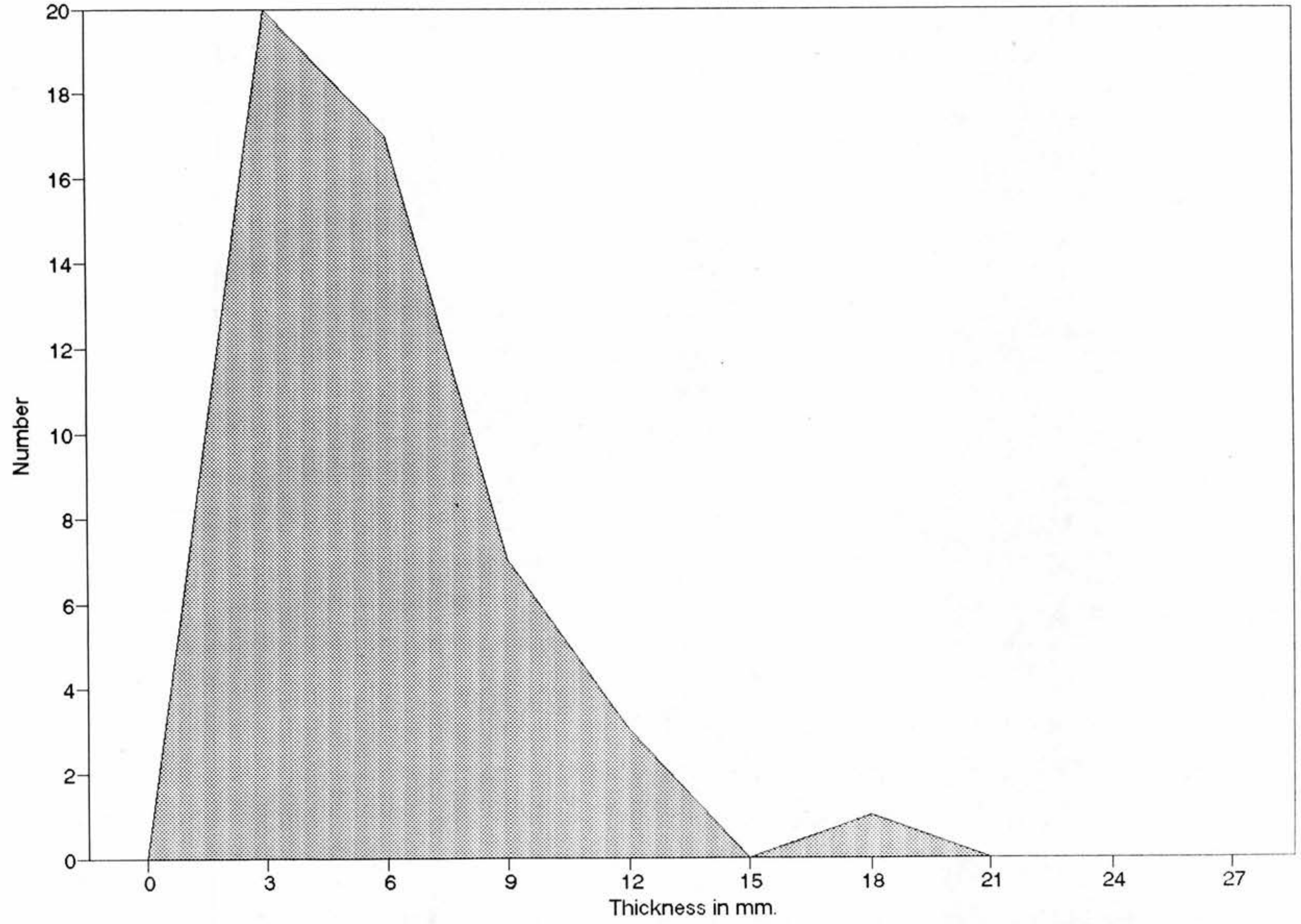


Fig 6.104: Azraq 31 PPNB Platforms
Frequency distribution of widths

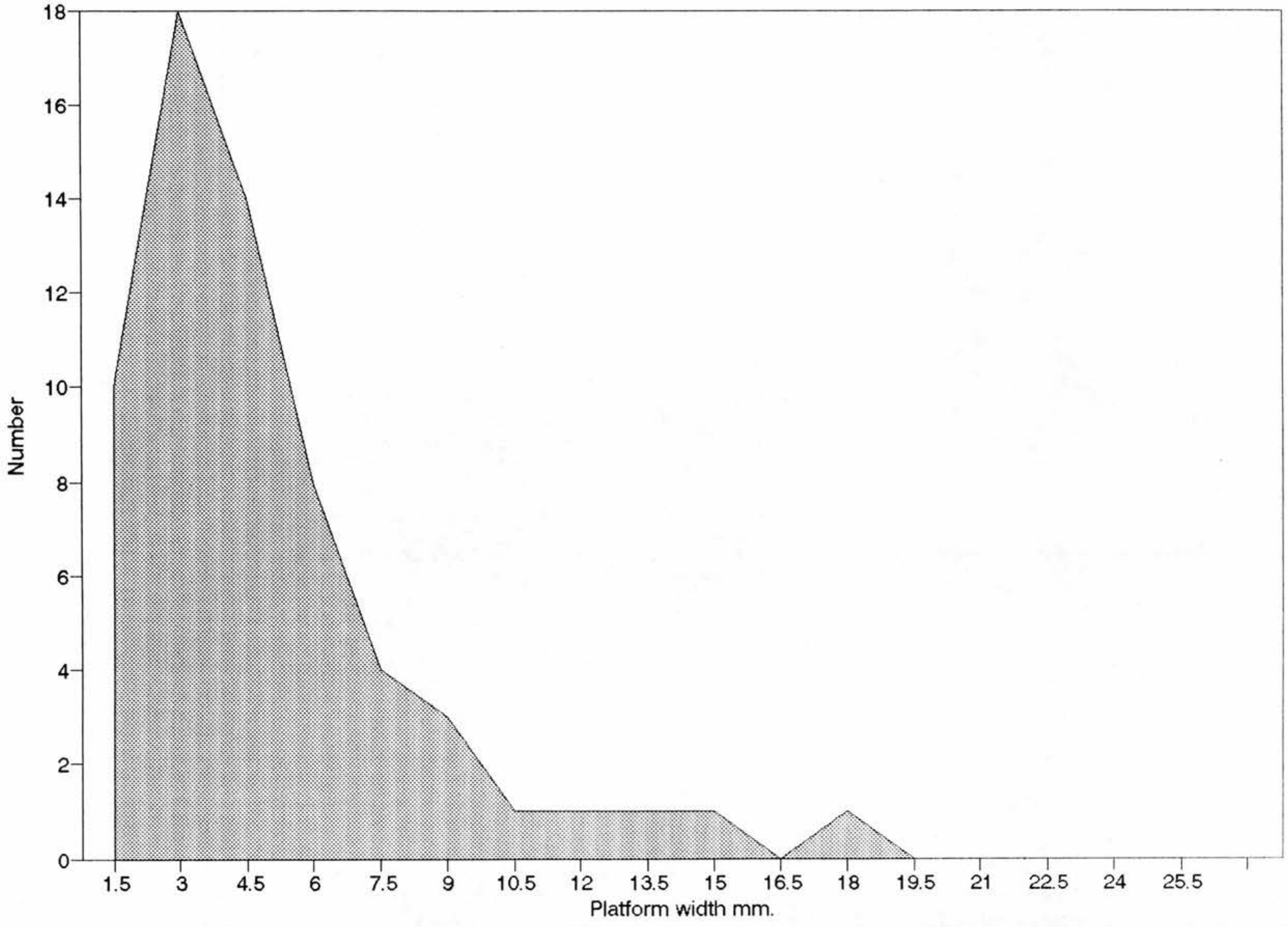


Fig 6.105: Azraq 31 Late Neo Platforms
Frequency distribution of widths

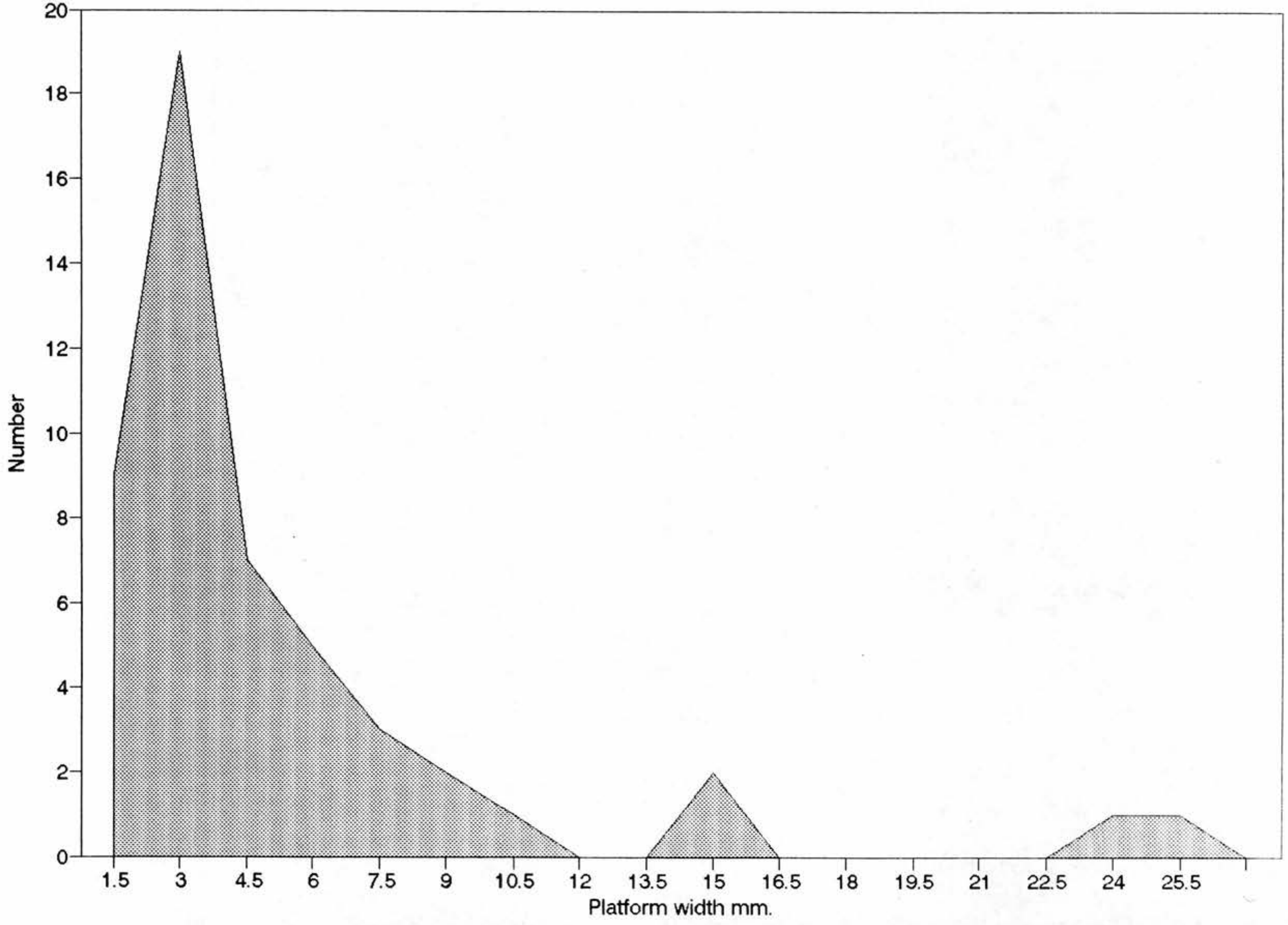


Fig 6.106: Azraq 31 PPNB Platforms
Frequency distribution of heights

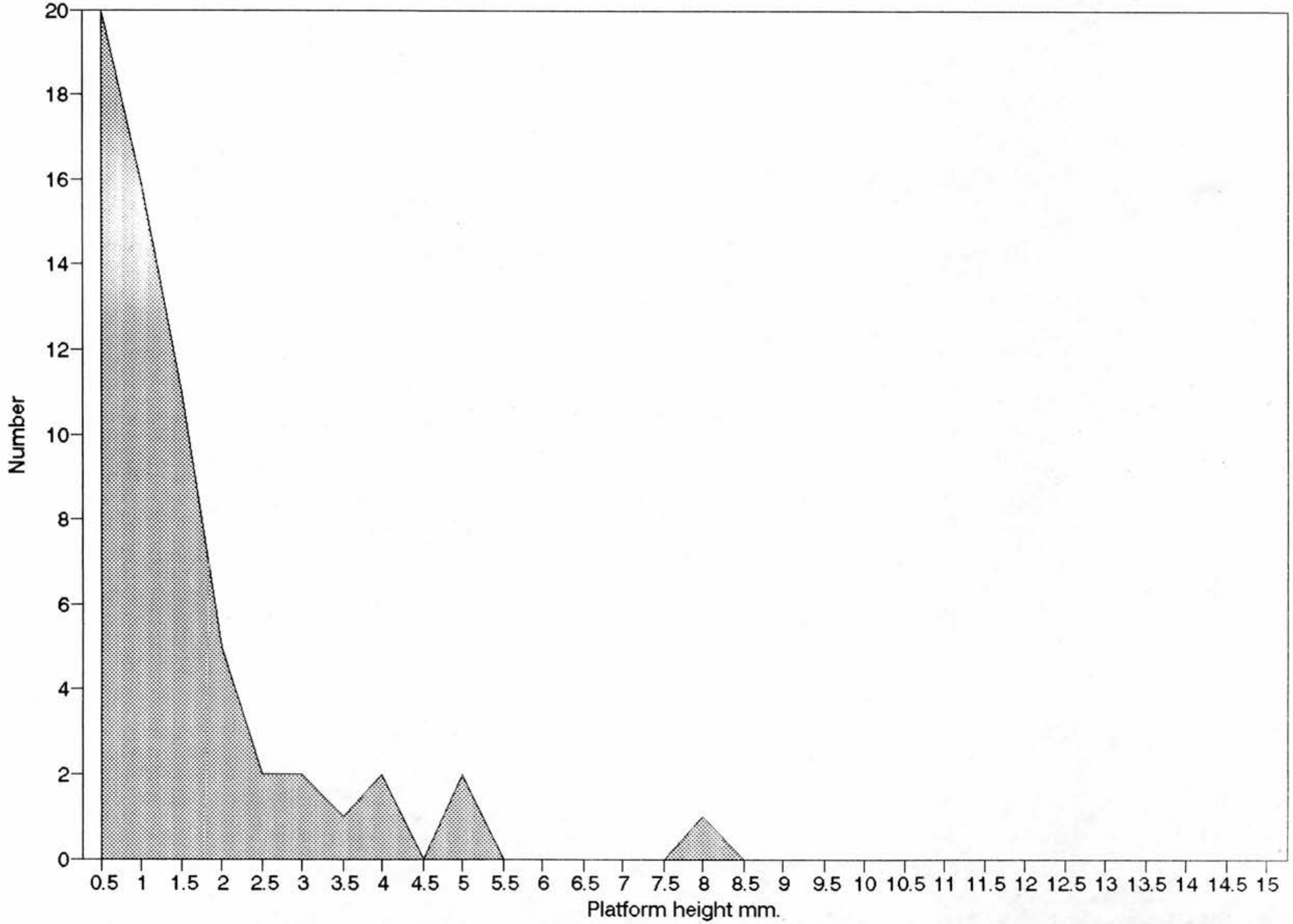


Fig 6.107: Azraq 31 Late Neo Platforms
Frequency distribution of heights

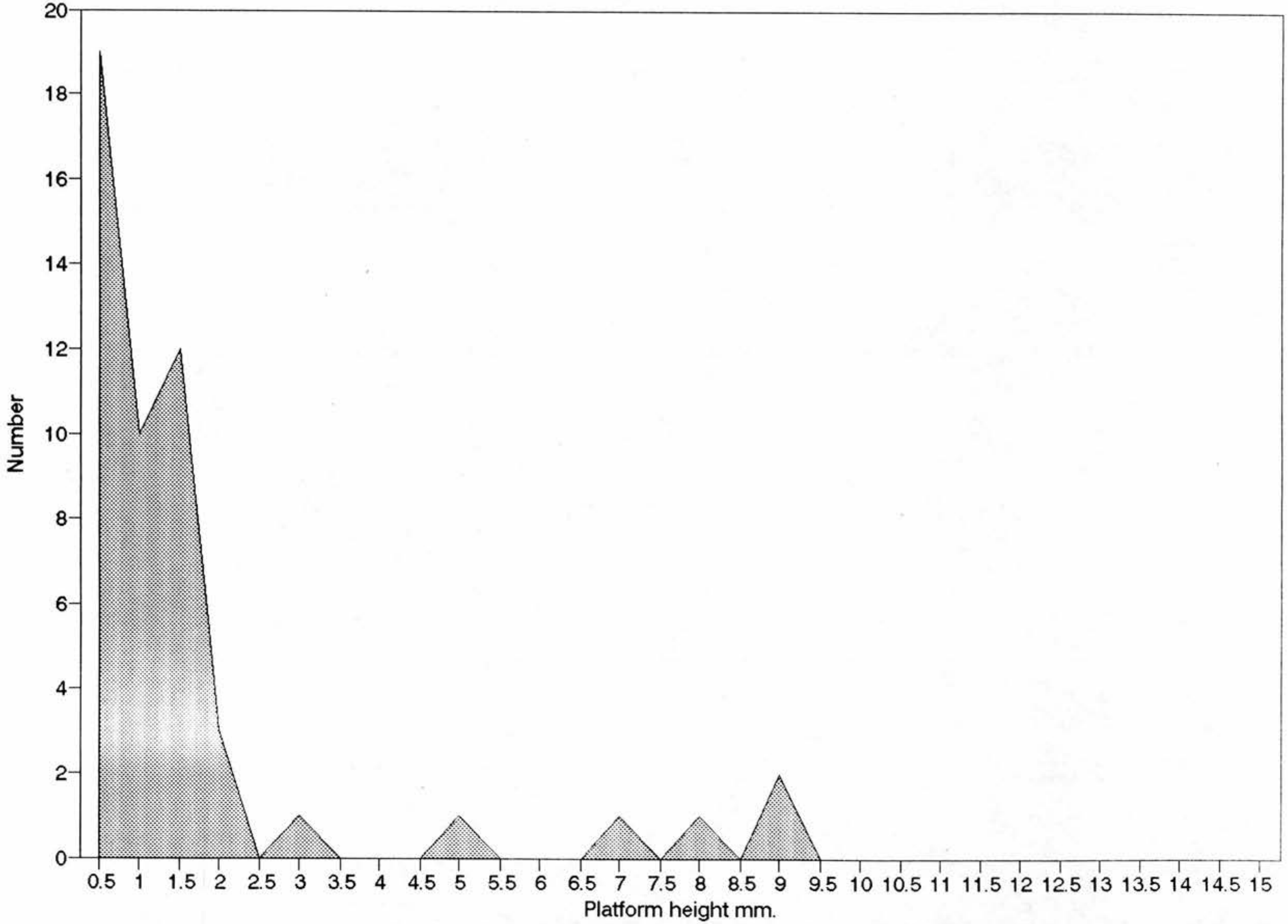


Fig 6.108: J7 Phase I Platforms
Frequency distribution of widths

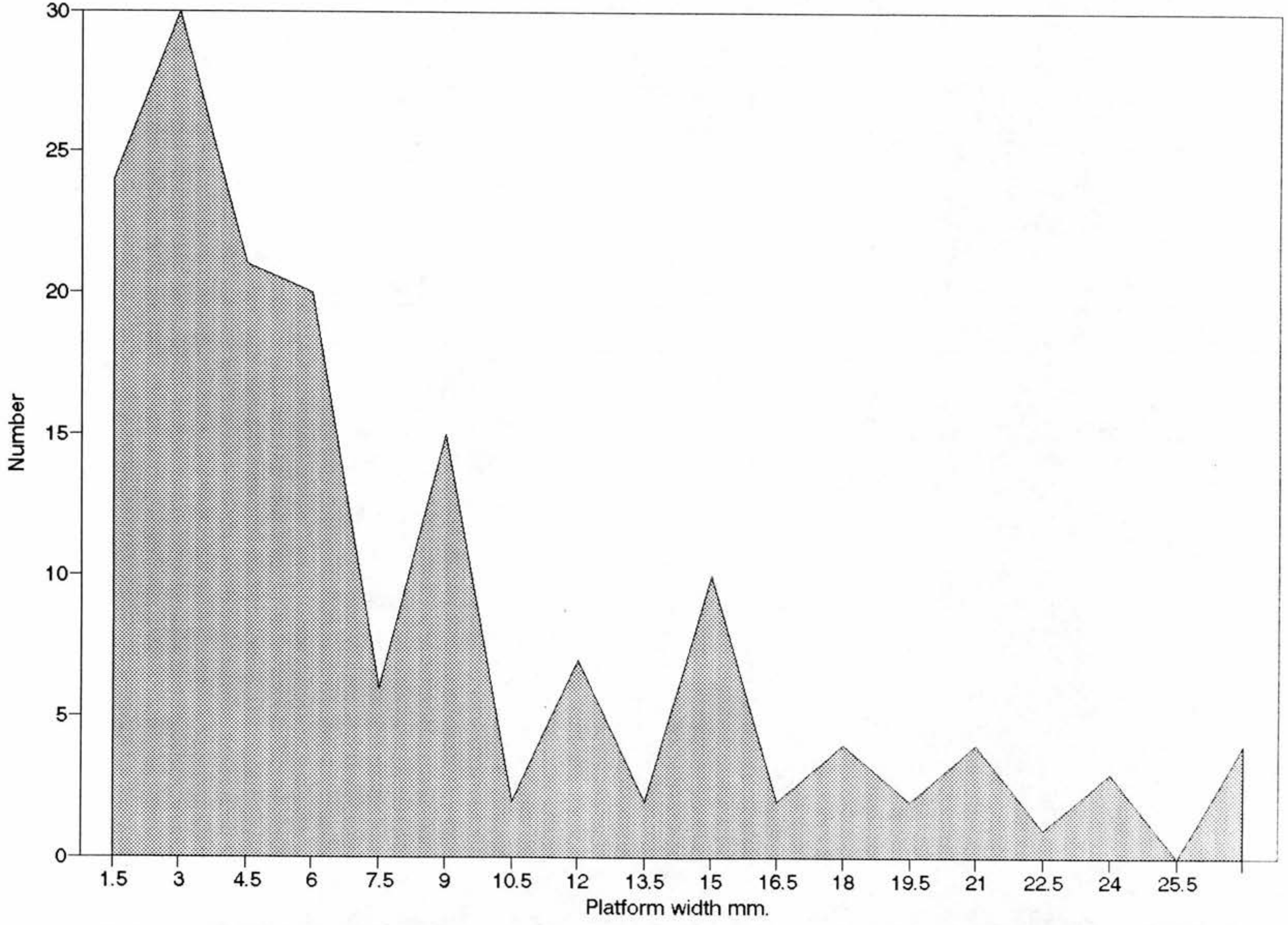


Fig 6.109: J7 Phase I Platforms
Frequency distribution of heights

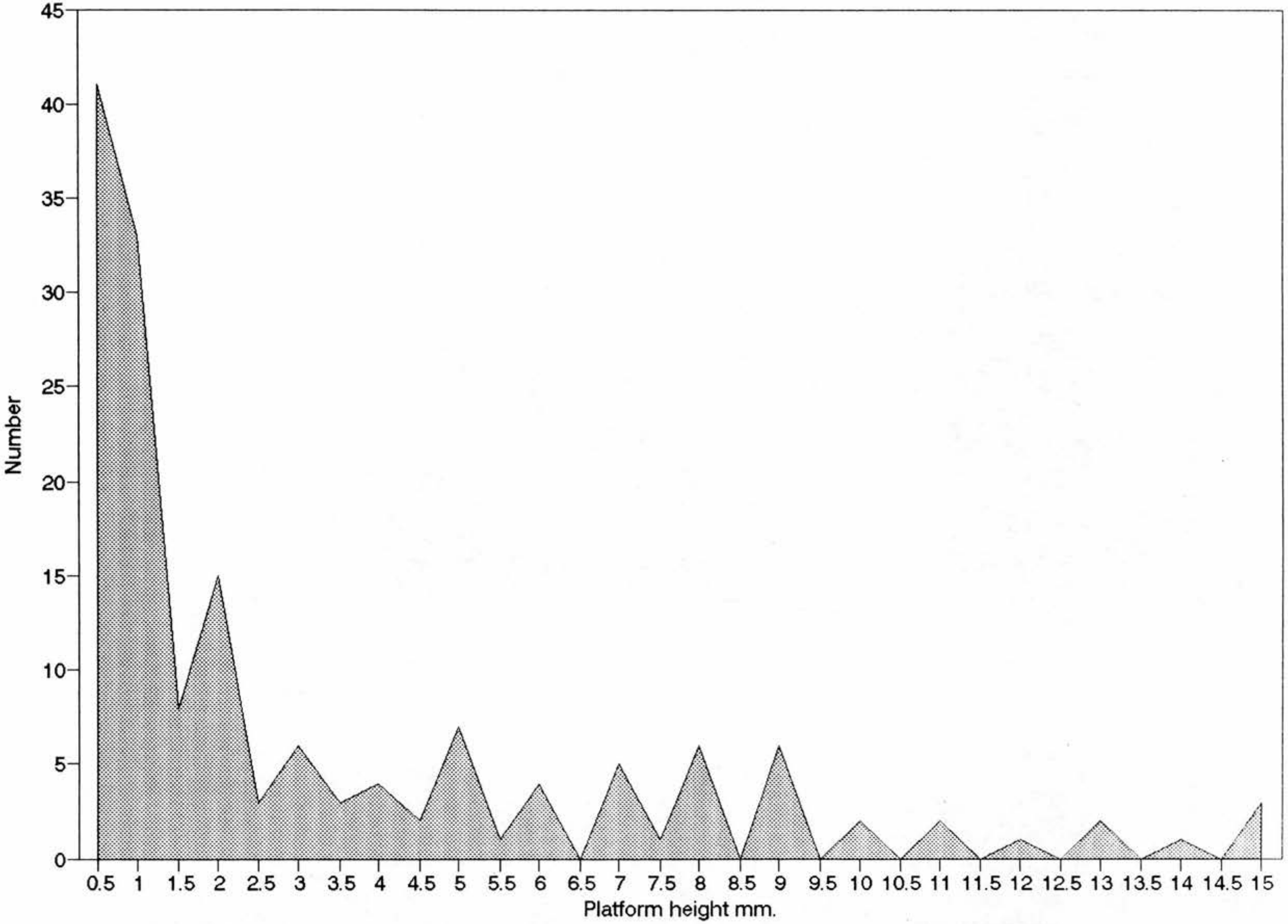


Fig 6.110: J7 Phase II Platforms
Frequency distribution of widths

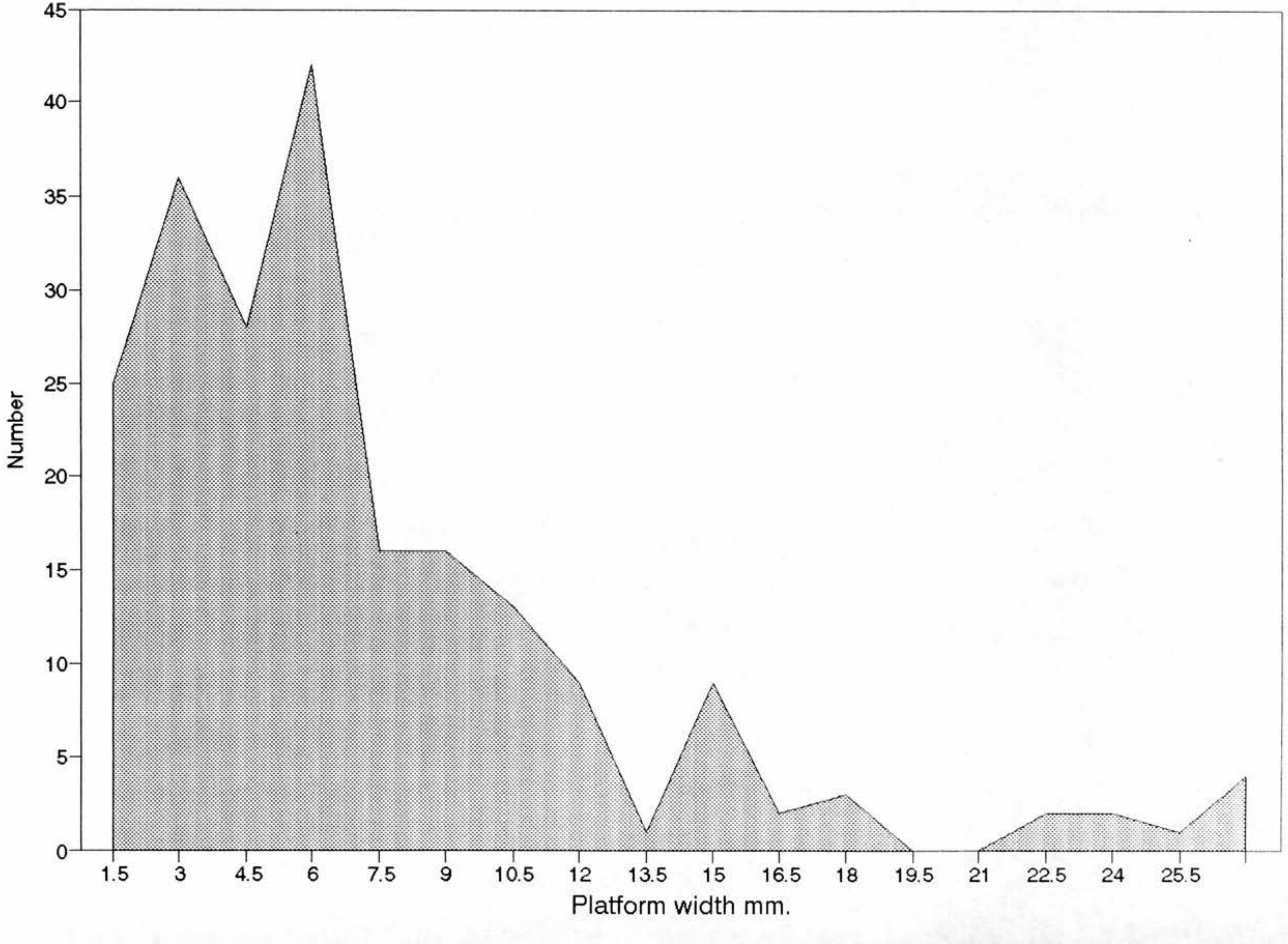


Fig 6.111: J7 Phase II Platforms
Frequency distribution of heights

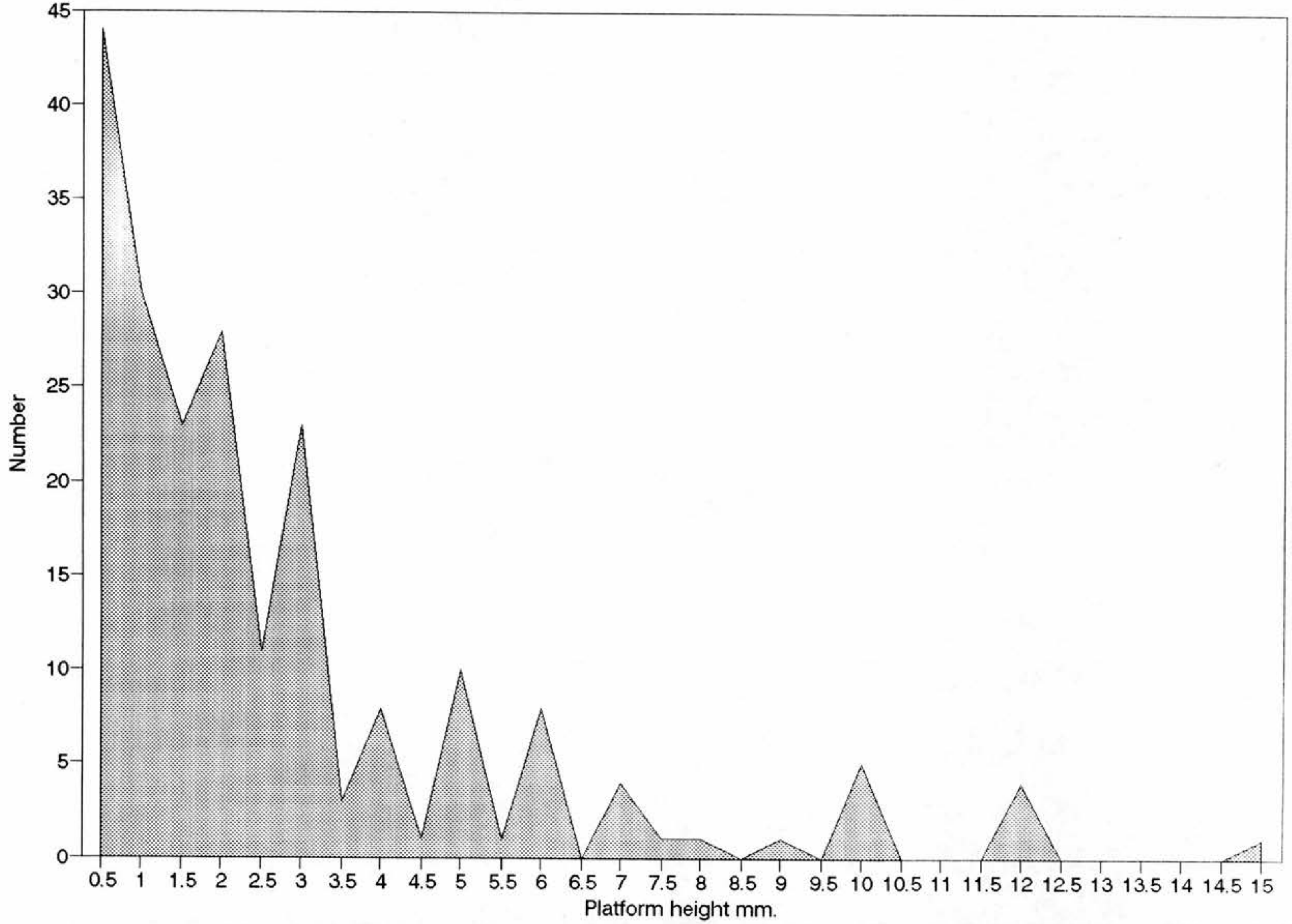


Fig 6.112: J7 Phase III Platforms
Frequency distribution of widths

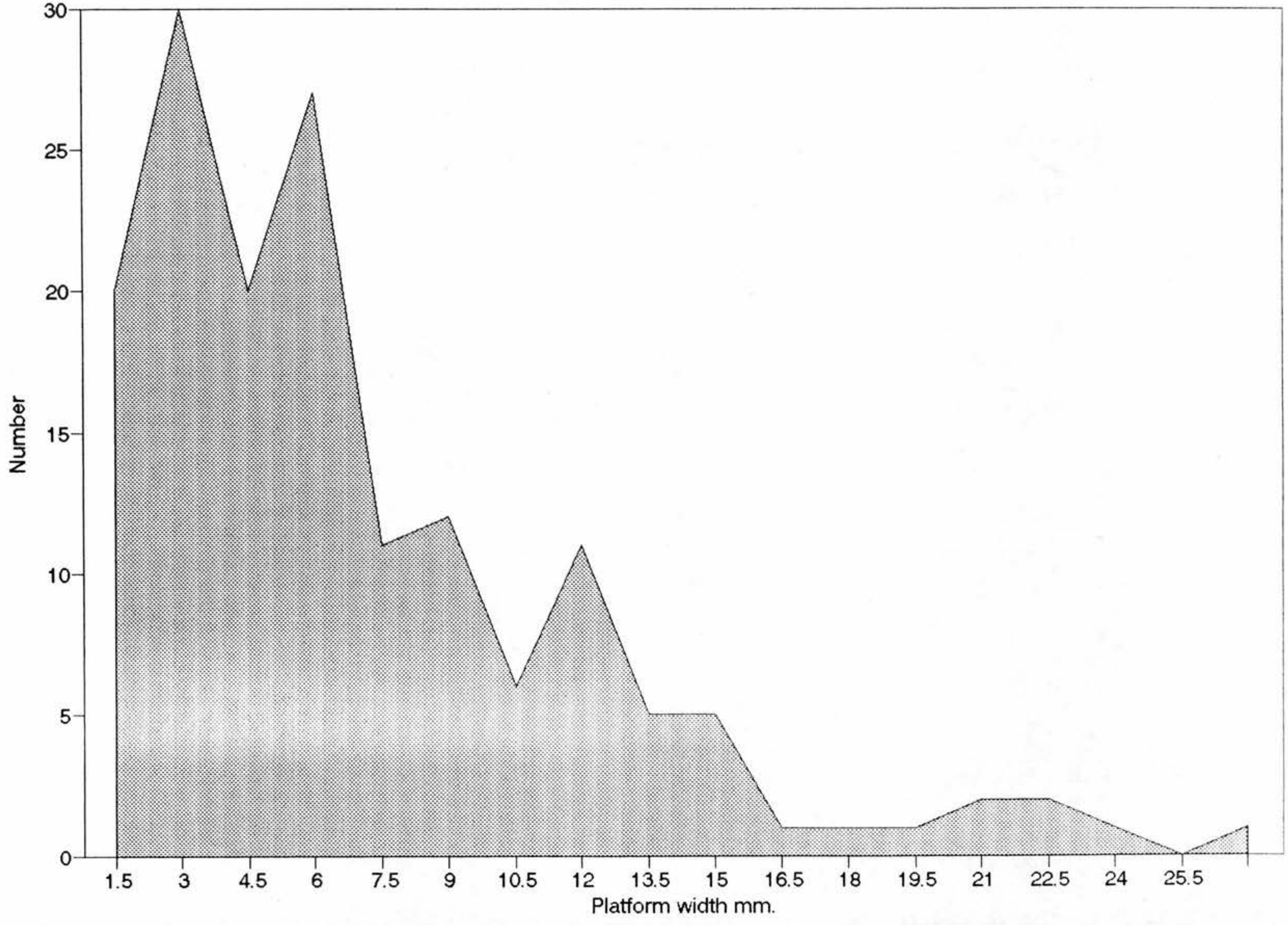


Fig 6.113: J7 Phase III Platforms
Frequency distribution of heights

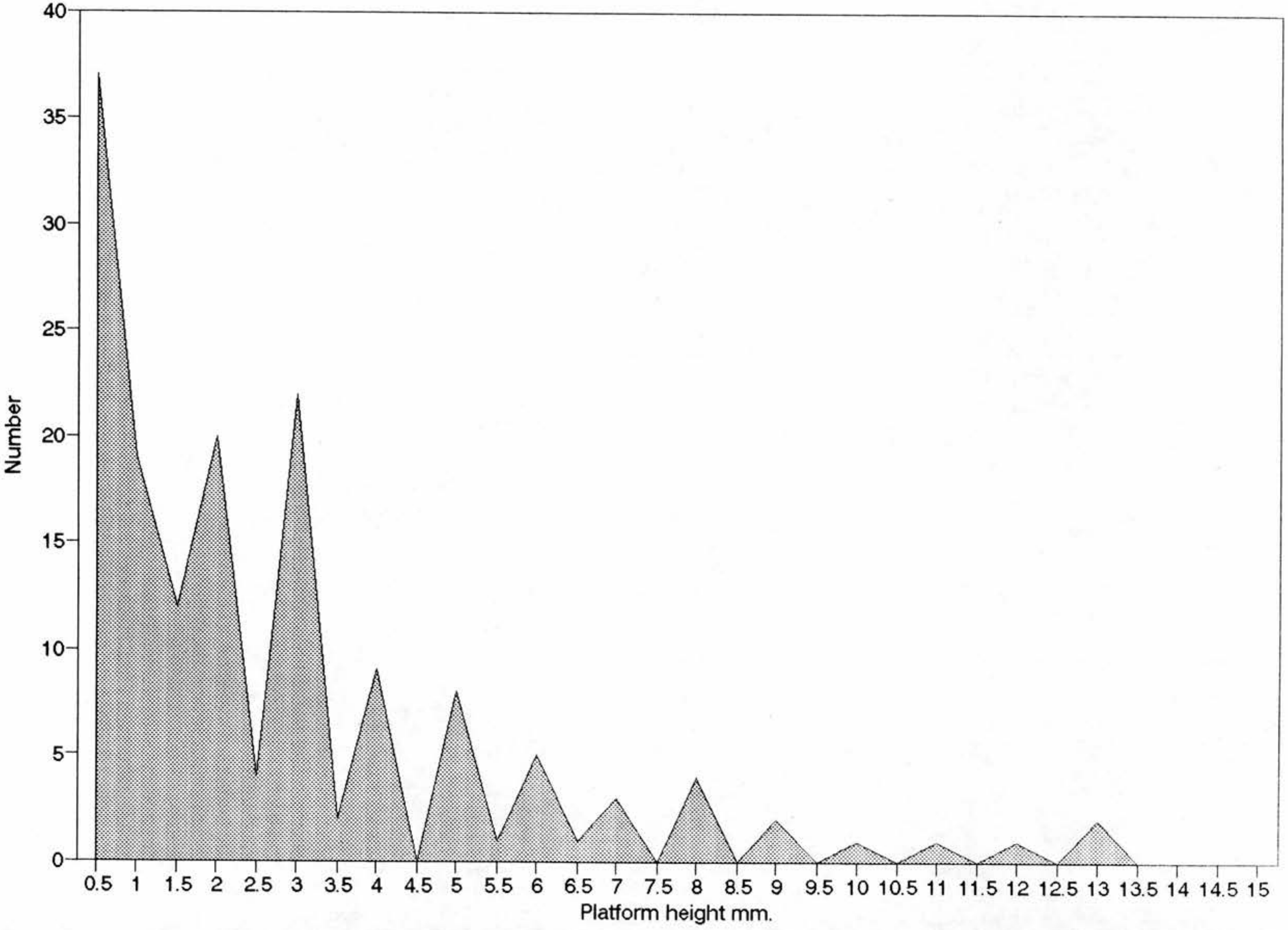


Fig 6.114: J26 Platforms
Frequency distribution of widths

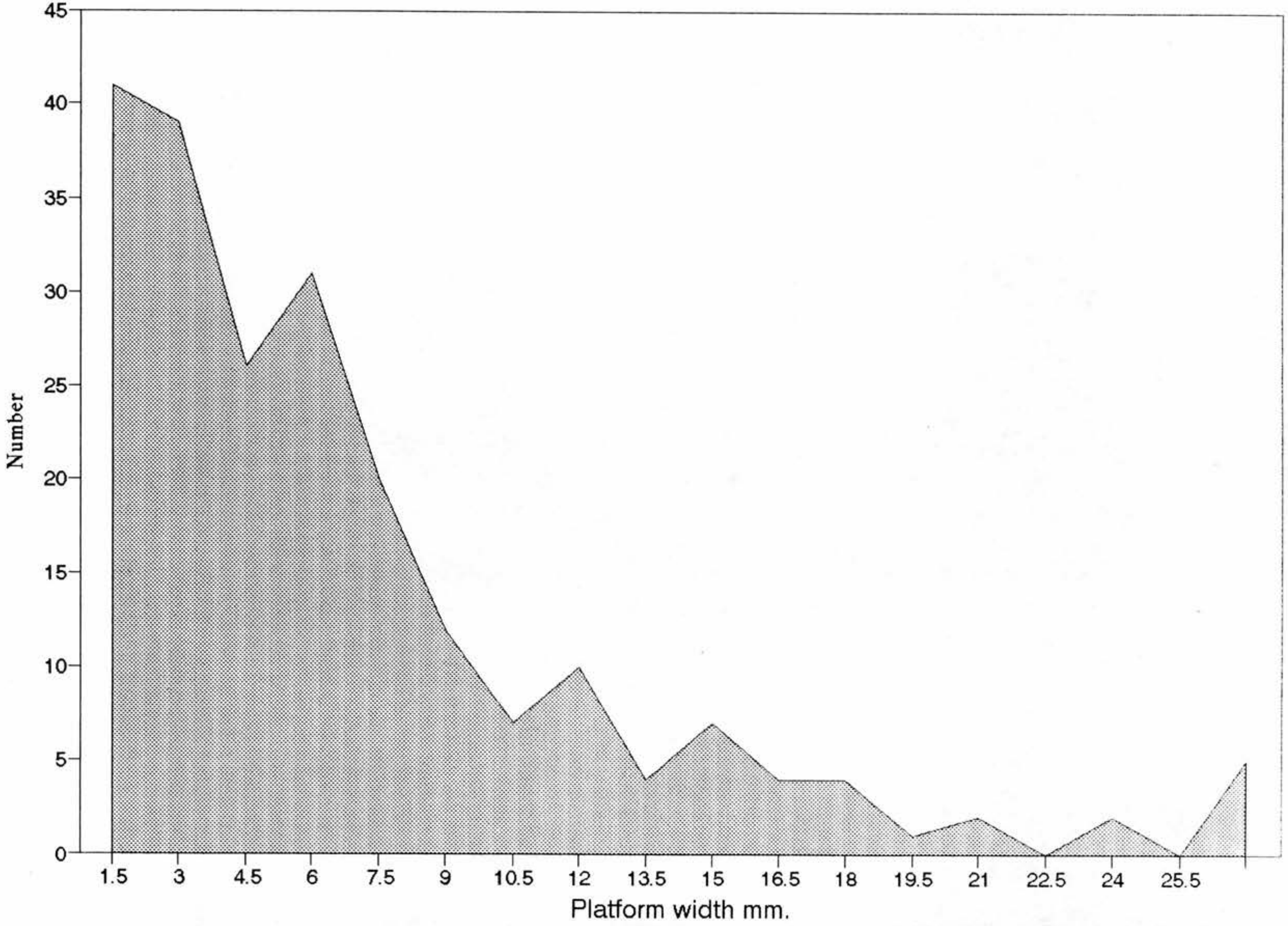


Fig 6.115: J26 Platforms
Frequency distribution of heights

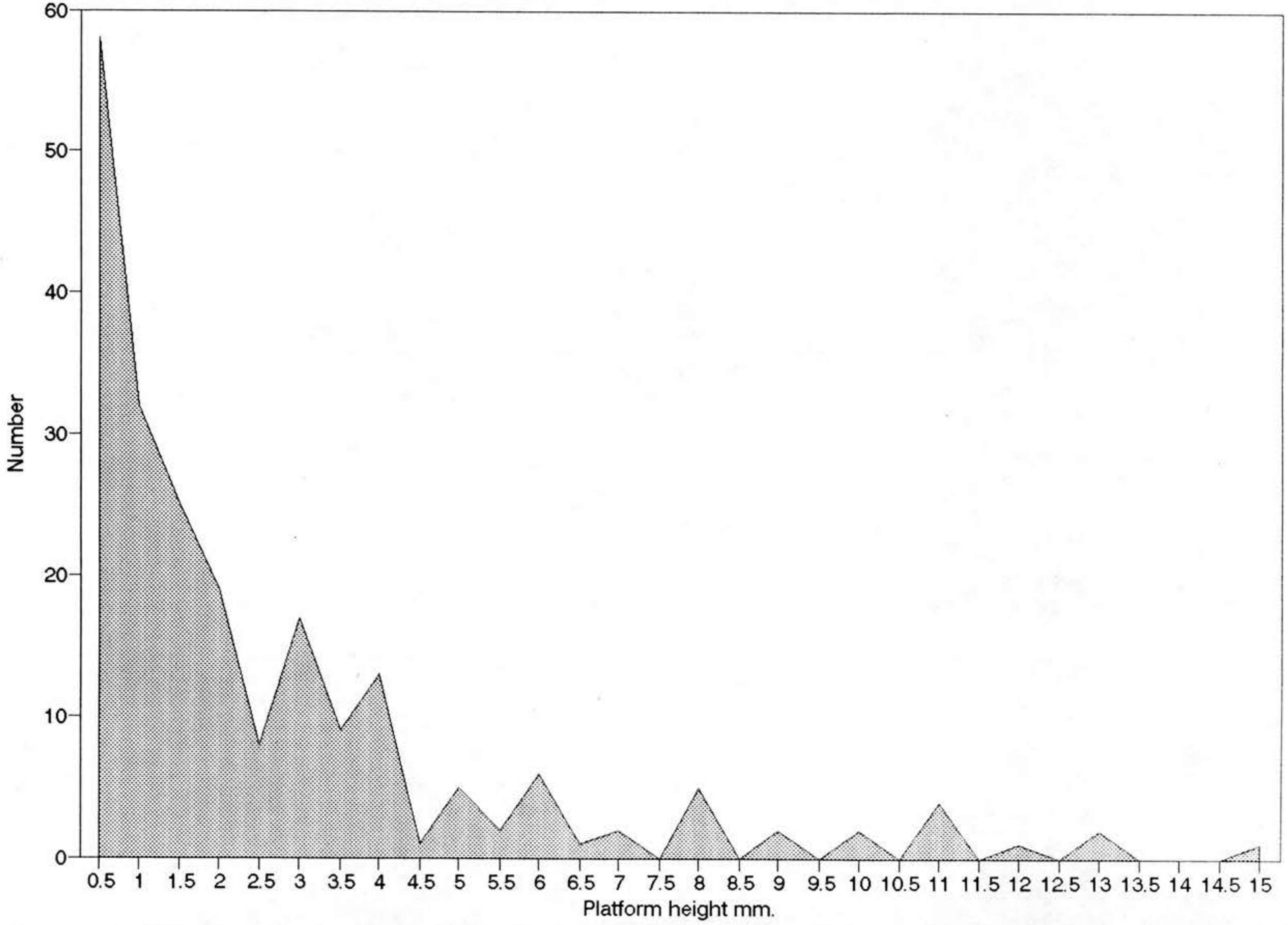


Fig 6.116: J32 Platforms
Frequency distribution of widths

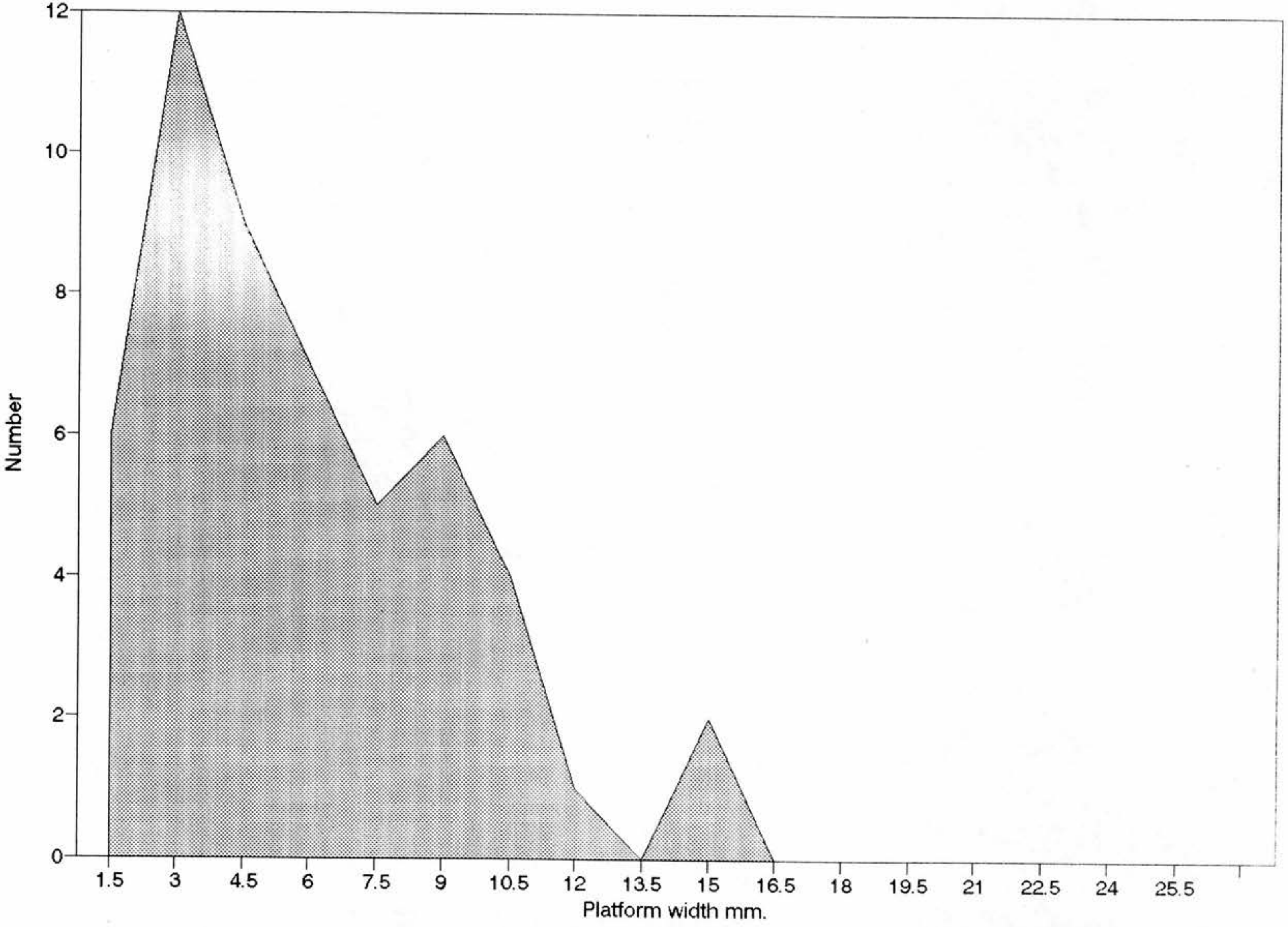


Fig 6.117: J32 Platforms
Frequency distribution of heights

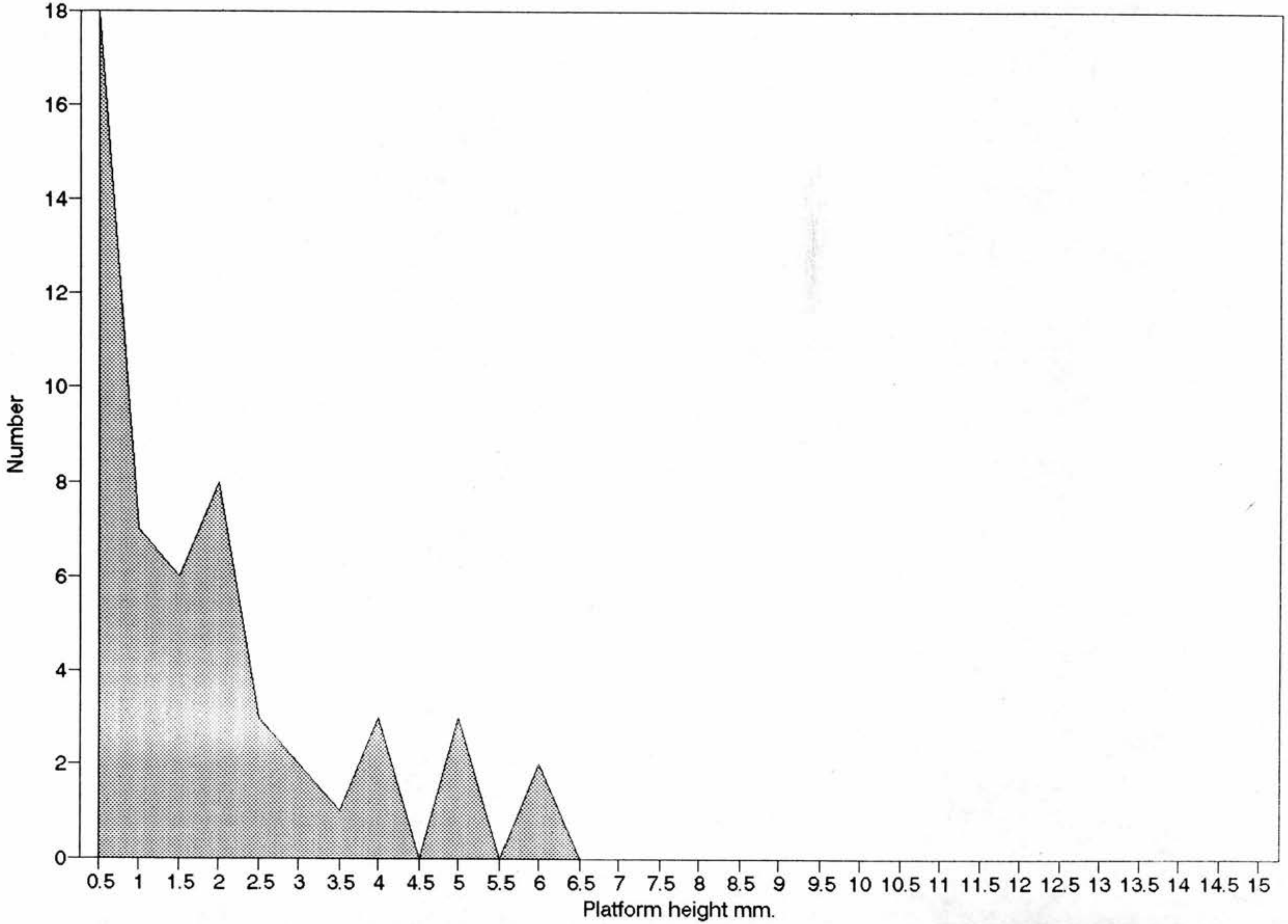


Fig 6.118: J13 Phase I Platforms
Frequency distribution of widths

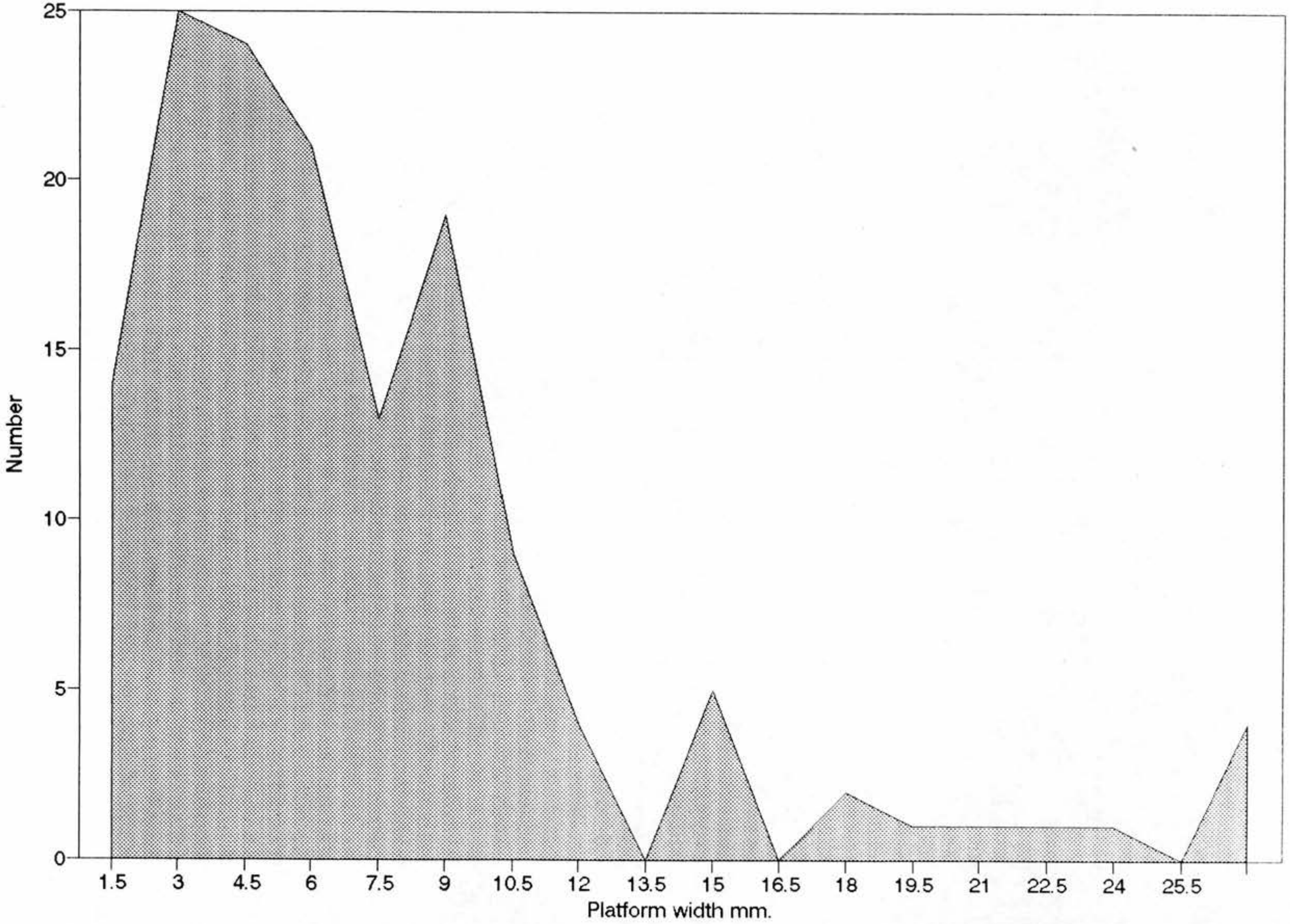


Fig 6.119: J13 Phase I Platforms
Frequency distribution of heights

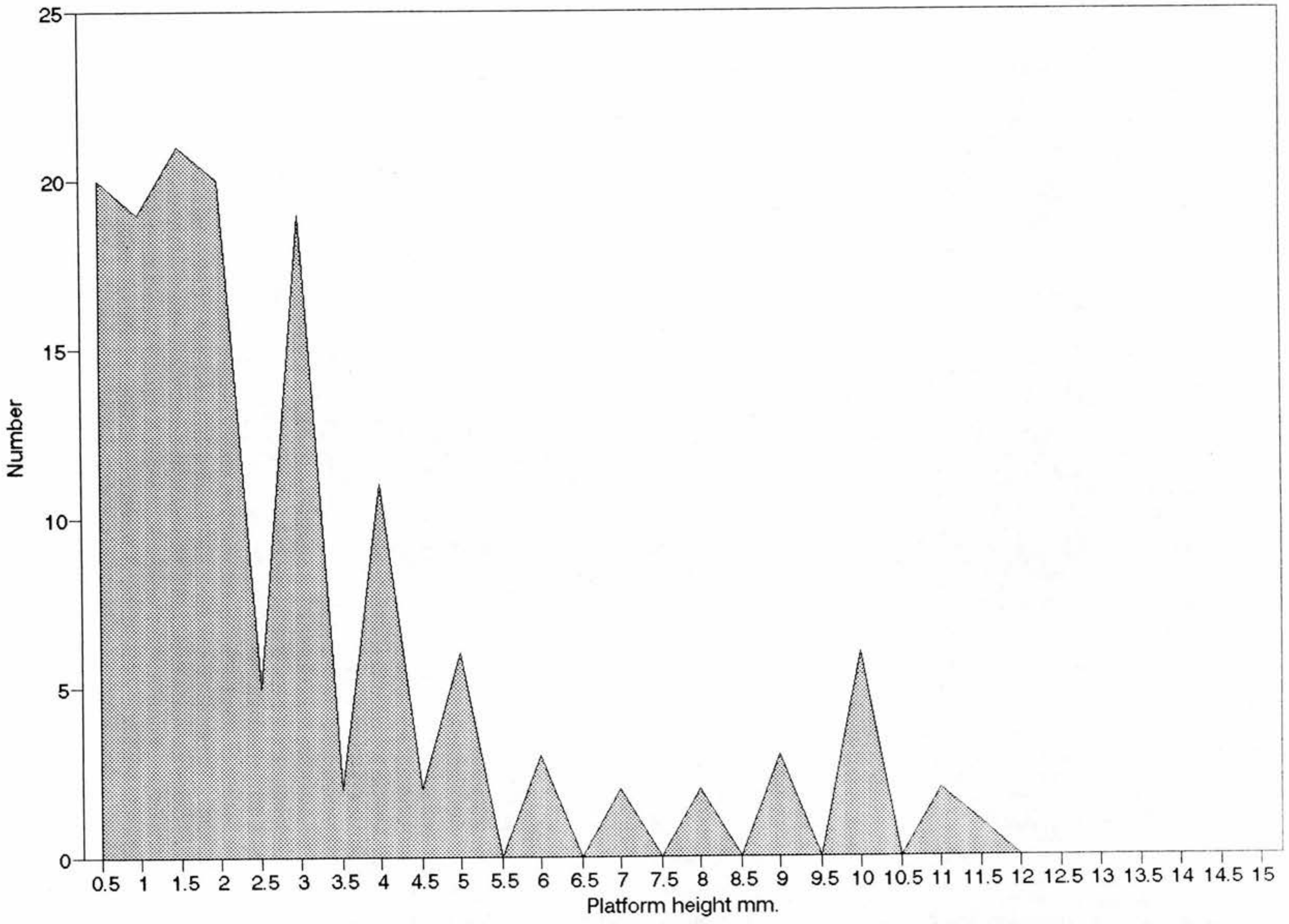


Fig 6.120: J13 Phase II Platforms
Frequency distribution of widths

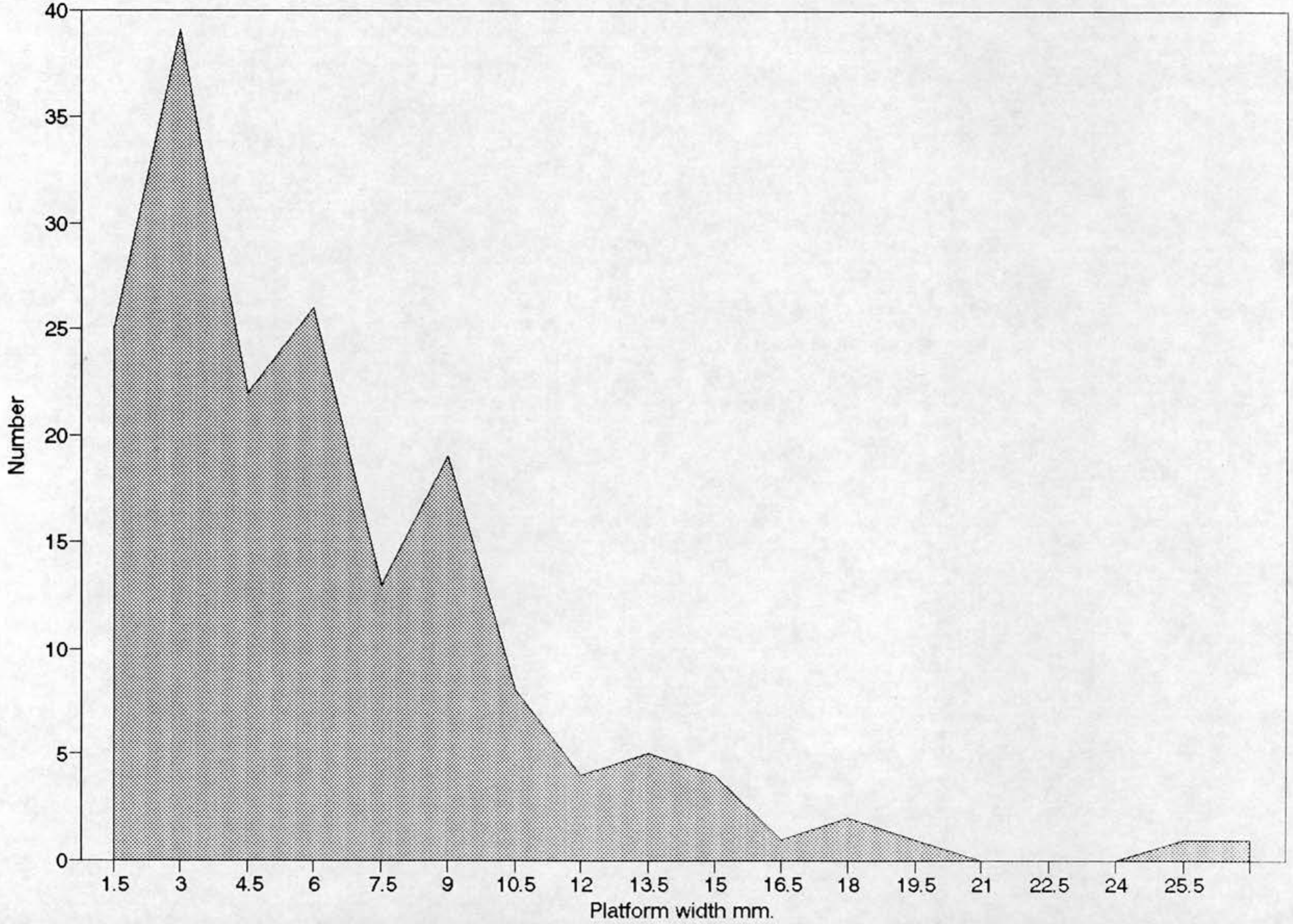


Fig. 6.121 J13 Phase II Platforms
Frequency distribution of heights

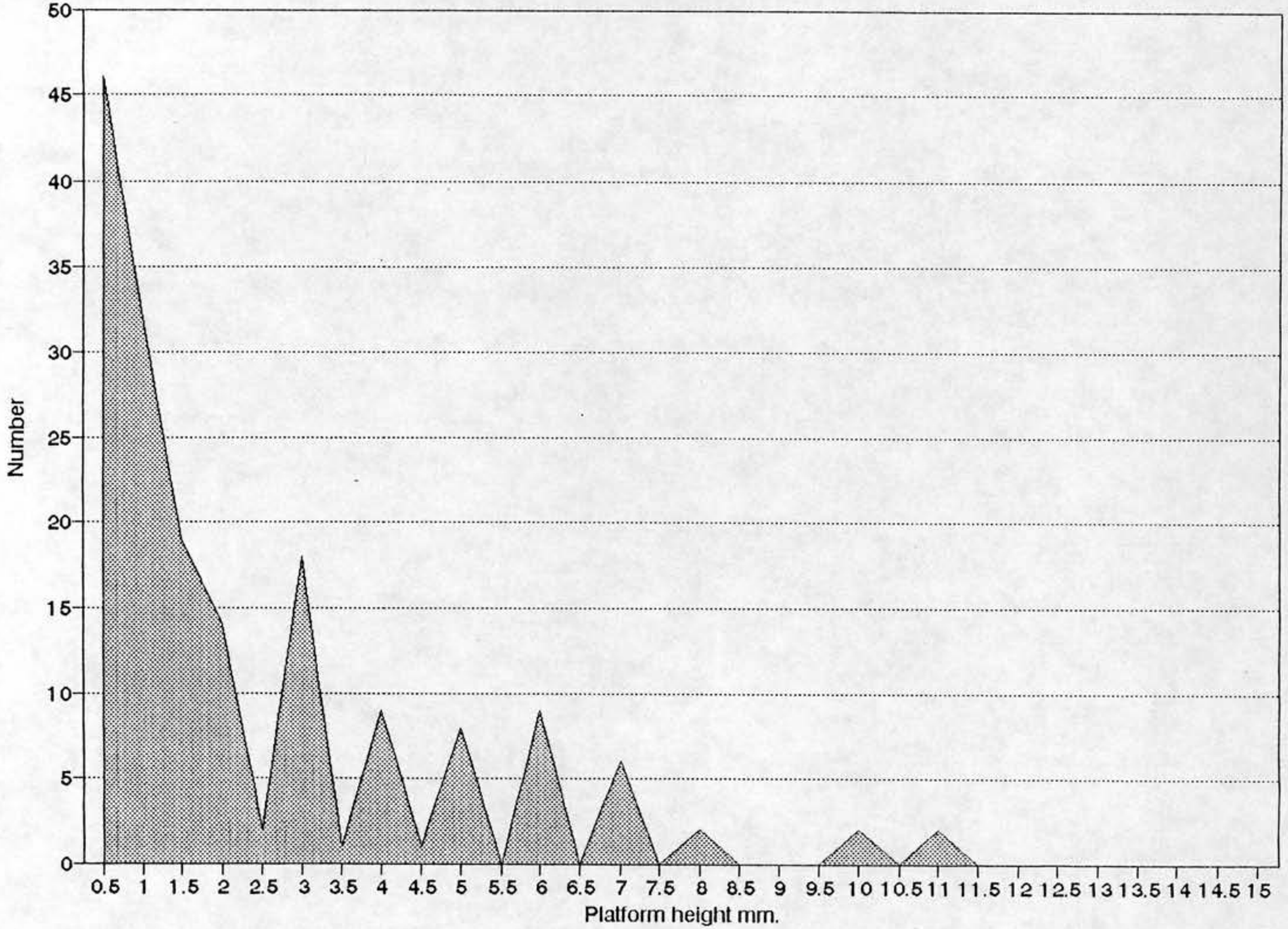


Fig 6.122: J25 Platforms
Frequency distribution of widths

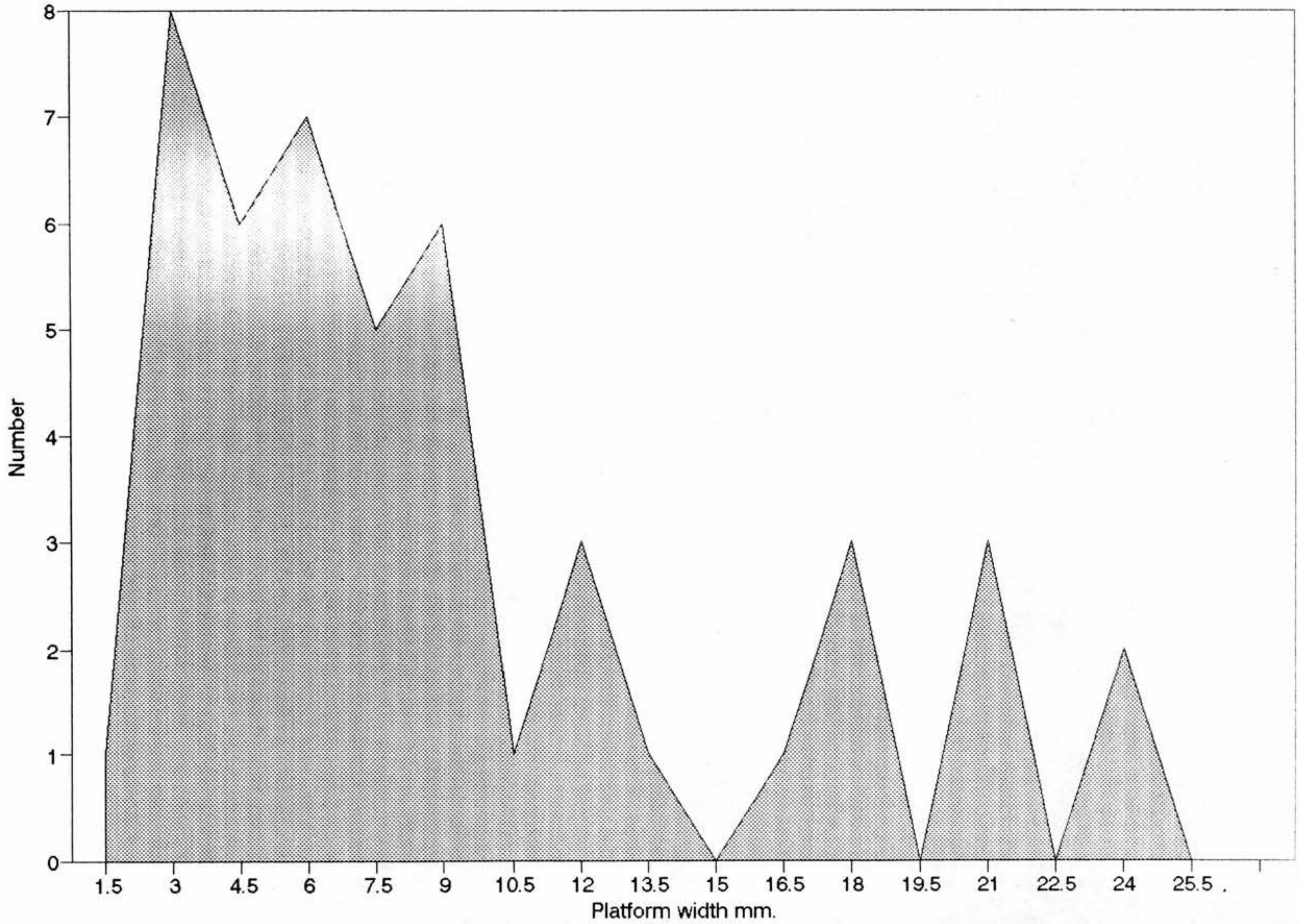
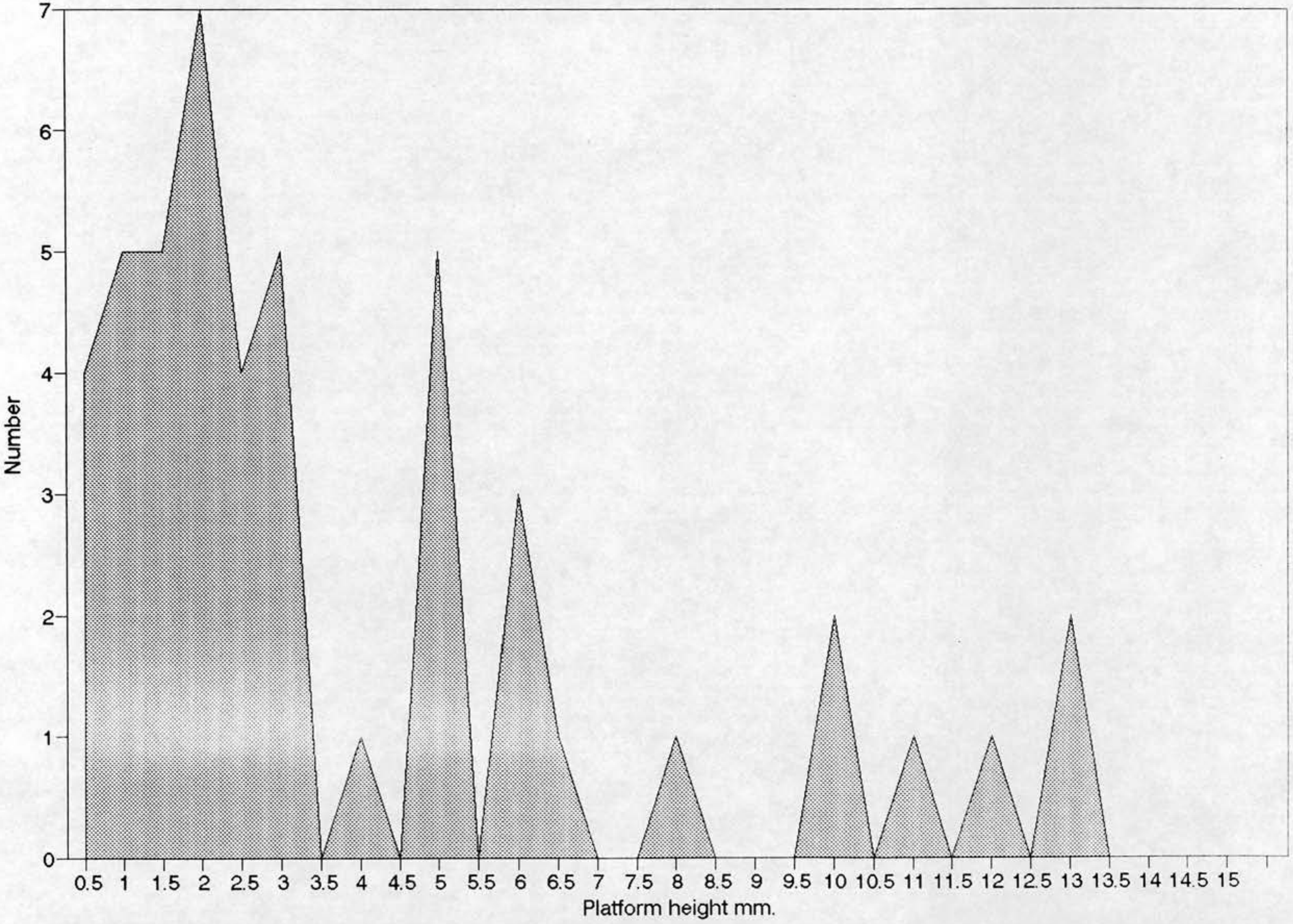


Fig 6.123: J25 Platforms
Frequency distribution of heights



SECTION 7

DEVELOPMENTS IN CHIPPED STONE PRODUCTION TECHNOLOGY IN THE SOUTHERN LEVANT AND THE COMPARATIVE STATUS OF AZRAQ BASIN NEOLITHIC PRODUCTION TECHNOLOGY.

Section 7.1 Mediterranean zone sequences.

There are three key sequences that cover the periods under study, which have data relating to technological developments and which are, at the same time, currently well enough documented to allow a degree of comparison with the Jilat and Azraq data. The chronology of these sequences has been detailed in section 4 (table 4.2). The lengthiest, but probably not continuous sequence, is provided by the Jericho tell (section 4.2.2). Unfortunately recovery procedures were limited, by modern standards, and whilst a final publication is available, the data relating to technology is not very detailed (Crowfoot Payne 1983). A second, probably continuous sequence is provided by Ain Ghazal. As a recent excavation recovery procedures were more akin to those employed on the Azraq project. Data collection and analysis are also being conducted to comparable degrees. Unfortunately results are preliminary so far and publication of them piecemeal. As the closest Mediterranean zone sequence to the Azraq basin (section 3.3) and because the site is located so close to the steppe, the data is of particular relevance. The third sequence is provided by a series of sites on, or close to, the steppe/Mediterranean boundaries in the Edomite highlands in the south of Jordan (sections 3.2-4 and 4.2). These are the sites in and around Beidha and Basta. Beidha was excavated some time ago and recovery procedures were limited. Technology is published in only preliminary and restricted form. The project at Basta is on-going; data analysis and publication are comparable to those for Ain Ghazal. The location of Basta at the point of transition from moist to arid settings in the modern context also makes the evidence from this site particularly relevant.

Section 7.1.1 Jericho

Section 7.1.1.1. PPNA

It is unclear whether a well defined Early PPNB phase exists at Jericho. The 8th M.b.c. occupation, the PPNA, at Jericho almost certainly predates the Early PPNB in Jilat. There are, however, many similarities between the technology documented for PPNA Jericho and Early PPNB J7. The most significant difference is the absence of naviform strategies from the PPNA. The evidence from Jericho allows us to perceive Early PPNB production technology in Jilat as a clear continuance of that typical of the PPNA in the Mediterranean zone, with the addition of a small component of naviform strategies. The frequency and character of other reduction strategies in the two assemblages are very similar. This can be seen in terms of the reduction strategies in their widest sense. At Jericho in the PPNA single platform cores are c. 39% of cores, change of orientation, multiple and irregular, c. 41% and opposed platform c. 18% (Crowfoot Payne 1983, 640). This dominance of single platform and change of orientation strategies is difficult to assess precisely because irregular cores were grouped by Crowfoot Payne with change of orientation types. It does, however, seem to reflect a situation similar to that at J7 Phase I amongst non-naviform cores (section 6.5.1). In fact, if naviform cores are excluded from the J7 Phase I sample, the figures for core types recomputed, and irregular and multiple platform cores grouped with change of orientation, then very similar proportions of three groups comparable with those at Jericho emerge (tables 6.6 and 6.7). These broad strategy groups include diverse types, but those illustrated (Crowfoot Payne 1983, fig. 264) can be precisely paralleled at J7. In particular, small, pyramidal single platform and change of orientation, bladelet cores (fig. 6.1)(Crowfoot Payne 1983, fig. 264:1, 3, 4) and prismatic, opposed platform, bladelet cores are identical (Crowfoot Payne 1983, fig. 264:5).

The small size of many Jilat Early PPNB cores has been noted and been related to the importance of bladelet production (section 6.5.2; fig. 6.1). Bladelets provided the blanks for the most distinctive tool types, Khiam and Helwan points, Hagdud truncations and the slender piercers (figs. 4.1:1-7; 4.5:9-12; 8.2:2 and 3). The small size of the bulk of the Jericho PPNA cores is noted. The smallest have maximum dimensions of c. 20 mm. (Crowfoot Payne 1983, 640). That, at Jericho, this is probably also linked to the production of bladelets is indicated by the frequency distribution of the lamellar debitage lengths which Crowfoot Payne quotes. Even in a recovery environment lacking sieving, the vast bulk of blade-bladelets occur in the 20-60 mm. size range and very few are longer. The low proportion of 0-20 mm. long bladelets can almost certainly be ascribed to lack of sieving, as these are common in all the Jilat and Azraq assemblages, for example (section 6.7.2). Specific trenches at Jericho, EI and II, V and M, where a different raw material was more common, produced a blade-bladelet debitage assemblage where the bulk of elongated debitage was under 40 mm. in length. Whilst direct comparison may not be appropriate, these figures suggest a situation more akin to J7 Phase I than to any of the 7th or 6th M.b.c. assemblages dealt with in this analysis.

Little information is available as to technique. Preparation of the edge of the platform on the main removal surface is very common (Crowfoot Payne 1983, 641), although unfortunately unquantified. Punctiform platforms are stated to be moderately important and it is clear Crowfoot Payne (1983, 641) includes filiform platforms in this category. In Jilat and Azraq such platforms seem closely associated with softer hammer/indirect percussion/pressure parts of technique spectrum. Crowfoot Payne specifically mentions bruising at the point of impact on these platforms, which might be associated with harder hammer techniques if the bruising included ring cracks, for example. We must take these observations as inconclusive, although it suggests that, as in Jilat in the Early PPNB, both areas of the technique spectrum were employed during blade-bladelet manufacture (sections 6.8.2-6.8.4). Whilst punctiform+filiform platforms and platform edge removal surface preparation are relatively significant in the Early PPNB on J7 (table 6.12), by the standards of later Jilat PPNB assemblages, the indication is that they are not as important as they are intimated to be at Jericho in the PPNA. However, without quantification the evidence retailed for Jericho must be used with circumspection.

Section 7.1.1.2 Middle PPNB

As indicated in section 4.2.2-4.2.3 the bulk of the PPNB at Jericho is Middle PPNB and, therefore, coeval with J7 Phase II and/or J26, possibly J7 Phase III and probably J32. Some more detailed data is available on Middle PPNB cores and blade-bladelets from Area M, gathered by Nishiaki (1992).

By the Middle PPNB at Jericho naviform strategies had come to dominate and naviform cores occur in similar proportions, c. 42%, to the coeval sites in Jilat (section 6.5.1). These naviform cores include several types similar to those found in coeval assemblages in Jilat. These include, along with classic examples with crests directly opposite and parallel to the central axis of the main removal surface, a minority of examples with two crests 'opposite' the main removal surface, but not aligned with its central axis (sections 6.2.6, 6.3.2.6 and 6.5.6) (Crowfoot Payne 1983 fig. 294 and 292:2), some right angled reverse crests (Section, Crowfoot Payne 1983 fig. 293:3; Nishiaki 1992 fig. 4.30:1) and sub-naviform types with cortex on the reverse and no crest (Crowfoot Payne 1983, 667 and fig. 292:1; Nishiaki 1992 fig. 4.30:3). Decortication was extensive to judge from illustrations, even at the preform stage (Crowfoot Payne 1983, fig. 294). It is unclear whether tabular edge strategies were practised. Other than in this regard, it is clear that the character of naviform strategies were very similar to those effected in Jilat.

Platform angles of naviform cores at Jericho are stated to be c. 62°. This is lower than most angles recorded from Jilat but would represent the angle between parts of the main removal surface and the final platform position on Jilat cores as well (section 6.3.2.4). It is, therefore, suspected that this is the angle that Crowfoot Payne has recorded. It is a reflection of the frequent low platform angles generated in naviform core production (section 6.3.2.4).

Crowfoot Payne (1983, 667) was one of the first to appreciate the significance of differences between the precise character of the naviform reduction strategies at Jericho and those documented in the Palmyra basin by Suzuki and Akazawa (1971). In more recent analyses Nishiaki (1992, 147-148) has most effectively clarified and amplified the character of this specific form of naviform strategy which he terms the naviform method of Douara type. The key feature of this strategy is a tendency for blade removal to progress in only one and the same direction along both of the opposed platform edges, in the cases illustrated by Nisiaki from Douara cave level II, to the right (Nishiaki 1992, fig. 4.6). An important component of technique associated with this is that most blade-bladelet platforms show that the removal blow was struck on the right side of the platform. This produced the typical biased distribution of blade detachment scars on cores first noted by Suzuki and Akazawa (1971) and the slanting of the main removal surface in relation to the longitudinal axis of the core which resulted in many blade-bladelets with twisted profiles and distal ends curved in one direction; in the case of Douara cave II mostly to the right (Nishiaki 1992, 147-8). This Douara method Nishiaki has noted is absent from Jericho. It is also absent from Jilat and Azraq at any period.

Whilst the character of the naviform strategies was clearly very similar to coeval and other naviform reduction in Jilat, the sizes of cores at Jericho are not. Crowfoot Payne (1983, 667) states that Jericho cores range in length from minimum 100 mm. Nishiaki (1992 fig. 4.30:1) has illustrated a naviform core 90 mm. in length from Area M and a sub-naviform core 71 mm. long (Nishiaki 1992 fig. 4.30:3). Thus, we cannot take Crowfoot Payne's description as completely accurate, but it presumably relates to a considerable proportion of the cores. There is no Jilat naviforms over 100 mm. in length (section 6.3.2.3; figs. 6.52-6.53) apart from the cache in J7 Phase I deposits of 3 long naviform preforms/barely reduced naviforms which are 130-140 mm. long (figs. 6.6-6.8) 1 of which is plotted on fig. 6.52. The Jericho 90 mm. core is in the upper part of the range for Jilat naviforms and the 71 mm. core in the upper part of the range for Jilat sub-naviforms. The mean length of Jericho naviforms *sensu lato* is likely to be much higher than that of Jilat naviforms *sensu lato* and clearly most Jericho naviforms were longer than most Jilat and Azraq 31 naviforms. Most Jericho naviforms were wider than most Jilat and Azraq 31 naviforms; here statements and illustrations accord. Jericho naviforms are over 40 mm. thick whilst most Jilat and Azraq 31 naviforms are thinner than this (appendix 2). Naviform width relates to preform thickness and core thickness relates to preform width (section 6.5.2). Clearly most Jericho preforms were almost certainly considerably larger than most Jilat and Azraq 31 preforms. This cannot be ascribed to limited size of Jilat raw material, as plentiful raw material of suitable size to manufacture preforms, comparable to those of Jericho, existed in Jilat.

It is difficult to compare the size character of blade-bladelet debitage from Jericho with Jilat and Azraq 31 because of the lack of sieving at the former site. The highest proportion of any Jilat and Azraq 31 assemblage is in the 0-40 mm. length range (section 6.7.2) and only c. 18.5% of Jericho blade-bladelet debitage is in this range (Crowfoot

Payne 1983, 671). Of longer blade-bladelet debitage, for which comparisons are more valid, pieces in the range 40-60 mm. are most important at Jericho. This is undoubtedly the most important part of the Jilat and Azraq 31 longer blade-bladelet length range (section 6.7.2; figs. 6.78; 6.80; 6.82; 6.84; 6.86; 6.88; 6.90; 6.92; 6.94). On the other hand, there are significant numbers of relatively long blades from Jericho which are over 80 mm. in length. These, whilst undoubtedly over-represented relative to shorter blade-bladelets, because of the lack of sieving, are very rare indeed in Jilat. They are, however, present in significant numbers at Azraq 31 in the PPNB. It is not surprising that there is a contrast with Jilat in this regard, given the relatively large size of the Jericho naviforms compared to those in Jilat.

Non-naviform cores at Jericho include examples of many of the strategies practised in Jilat and Azraq in the 7th M.b.c., represented by prismatic opposed, other opposed, single platform and pyramidal cores, discoidal and irregular cores (section 6.5.1). In particular the relative importance of prismatic single and opposed platform cores at Jericho, second in importance to naviforms, is matched at coeval J26 and J7 Phase II (section 6.5.1). Unfortunately it is unclear whether tabular edge strategies were practised at Jericho.

Crowfoot Payne provides only limited information relating to technique aspects of reduction. She indicates that platform preparation on the removal surface was relatively frequent on blade-bladelet debitage (Crowfoot Payne 1983, 671). She indicates also that punctiform, probably plus filiform, platforms were important on blade-bladelets. Fortunately, Nishiaki (1992, 387-8, table 4.18) has provided more detailed data on blade-bladelet debitage from Area M. Nishiaki's thin platforms are filiform platforms (Nishiaki 1992, 96) and they occur in a much higher proportion, c. 43%, than on Jilat sites or even Azraq 31. Nishiaki's small platforms are punctiform and they, too, occur in a much higher proportion, c. 21%, compared to Jilat and even higher than Azraq 31 Late PPNB. A high proportion of Jilat 7th M.b.c. and, in particular, both period Azraq 31 platforms are very small and are probably closely related to punctiform and filiform platforms (section 6.8.2). This suggests that the Jericho, Jilat and Azraq platforms might be somewhat more comparable than these figures initially suggest. Punctiform and filiform platforms are generally isolated by platform preparation on the main removal surface(s). The fact that there are significant differences between Jericho and Jilat and Azraq 31, with regard to these platform types, can be inferred from the very high proportion of removal surface preparation on blade-bladelet debitage at Jericho, c. 92% (Nishiaki 1992, table 4.18). This is four to six times as frequent as similar preparation on any Jilat blade-bladelets of 8th to early 6th M.b.c. inclusive and c. three to three and a half times more frequent than such preparation at Azraq 31 in either period there (section 6.8.2; table 6.12). Further, of this preparation at Jericho almost all represents grinding rather than facetting. At some coeval or probably coeval occupations in Jilat (J7 II and III and J32) facetting is much more important (section 6.8.2; table 6.13). Even where grinding is more important, it is only ever slightly more important than facetting, for example at coeval J26 (section 6.8.2; table 6.13).

Nishiaki points out that tabular material was used for naviform cores at Jericho.

No data directly relevant to the presence of harder or softer hammer use at Jericho is provided by Nishiaki. However, the high proportions of filiform and punctiform platforms and platform preparation of the removal surface, associated with softer hammer end of the spectrum techniques in Jilat and Azraq (section 6.8.3), probably indicate high frequency of softer hammer related techniques.

Thus, whilst naviform and non-naviform strategies were clearly similar between Jericho and coeval sites in Jilat and Azraq, there are strong indications that techniques were different, even between Jericho and Late PPNB Azraq 31, which last approaches Jericho most closely in terms of technique indicators. Further, at Jericho, knappers created considerably larger naviform preforms as a matter of course, which probably resulted in the creation of more longer blades. Such blades are only seen with regularity on Late PPNB Azraq 31 among Azraq Project Neolithic sites.

Section 7.1.1.3 PNA

Unfortunately the poorly preserved PNA/Yarmoukian deposits at Jericho provided only a limited amount of material. This was particularly true of cores. In addition the probability of the derivation of much residual material from the massive underlying PPN deposit, much cut about by PNA pits, makes the material from the PNA deposits difficult to evaluate. Of the cores from PNA deposits Crowfoot Payne (1983, 706) thought that a number of single platform cores on wadi cobbles typified PNA production.

Section 7.1.2 Ain Ghazal

Ain Ghazal has a continuous sequence from Middle PPNB to PNA/Yarmoukian (section 4.2.2). Unfortunately, so little information relating to reduction strategies has been published that no comment on this aspect of technology can be made in relation to the Ain Ghazal sequence.

Rollefson (*et al* 1989) has demonstrated a shift in the proportions of different debitage types produced at Ain Ghazal from PPNB to Late Neolithic. In the Middle PPNB blade-bladelets slightly outnumber flakes. In the Late PPNB blade-bladelets occur in approximately equal proportion to flakes. In the PPNC flakes, c. 62%, outnumber blade-bladelets, c. 38%. In the Yarmoukian flakes are slightly more important c. 64% and blade-bladelets, c. 36% (Rollefson *et al* 1989, 12-13). The shift to flake production seems clear. It is interesting that the PPNC, coeval with the Early Late Neolithic in Jilat (sections 4.3.1 and 4.4.4-4.4.6), has a debitage assemblage relatively similar to the Late Late Neolithic/Yarmoukian. In the Early Late Neolithic assemblages on J13 and in the possibly Early Late Neolithic assemblage on Azraq 31, blade-bladelet debitage is as important as in the PPNB in Jilat and at Azraq, and more important than in the PPNB at Ain Ghazal, for example (section 6.7.1; figs. 6.74-6.76). In the Early Late Neolithic assemblage from J25 (almost certainly later than J13 Phase I), however, flakes are much more important (section 6.7.1; figs. 6.77). These developments reflect the trends noted at Ain Ghazal. They indicate, however, that the technological changes to which greater flake production is related, which does not necessarily involve a decreased interest in blade-bladelet production, at least as indicated by tool blanks (section 8.2), were not necessarily simple, uniform, synchronous or unidirectional.

Information has been published concerning aspects of technique at Ain Ghazal during some of these periods (Rollefson 1990). Currently, evidence relating to the Late PPNB is absent. Punch platforms, as described by Rollefson and Abu Ghaneima (Rollefson and Abu Ghaneima 1983, 462), include punctiform and filiform platforms. They almost certainly include a proportion of slightly larger filiform-like platforms and crushed blade-bladelet platforms as well. In the Middle PPNB at Ain Ghazal 70% of blade platforms were thus punctiform/filiform related. In the PPNC the proportion decreases to 17.56% of blades and bladelets and in the Yarmoukian the proportion of blade-bladelets with punch platforms has declined to 15.10% (Rollefson 1990, Table 1). The trend is clear and is reflected in the Jilat/Azraq 31 sequence by the difference in the proportions of filiform plus punctiform platforms between 7th M.b.c. assemblages and

J25 (section 6.8.2; table 6.12), as was the growth in the importance of flake production. As with the ratio between flakes and blades there are only slight differences between the Early Late Neolithic assemblages from J13, that from Azraq 31, and the 7th M.b.c. assemblages in the same setting (section 6.8.2; table 6.12). However, in each of these cases, the proportion of these platform types has decreased from 20% or over in the 7th M.b.c. in Jilat to c. 14% on the J13 occupations and from c. 40% at Late PPNB Azraq 31 to c. 34% at Late Neolithic Azraq 31 (section 6.8.2; table 6.12). Rollefson's punch platform category includes platforms that are not punctiform or filiform. These are a proportion of small and crushed platforms. It is, therefore, difficult to make exact comparisons between Azraq Project and Ain Ghazal material. These differences in categorization probably, at least partly, account for the dramatic degree of contrast in the proportion of the punch category at Ain Ghazal compared to Jilat and Azraq. 7th M.b.c. platforms from Jilat and Azraq 31 include a very high proportion of small platforms (section 6.8.2), clearly related to punctiform and filiform platforms, and a considerable number of these might be included by Rollefson's criteria into a punch category, as would some of the crushed platforms. I would suggest that the Azraq 31 platform assemblages are likely to be more comparable with those from Ain Ghazal than figures might initially suggest. The high proportion of punctiform+filiform platforms at Ain Ghazal is probably comparable with the relatively high proportion at Jericho. Even with the addition of a certain proportion of the small plain and crushed platforms to the Jilat punctiform and filiform types, it is unlikely that a punch category *sensu lato* in Jilat 7th M.b.c. assemblages (section 6.8.2; table 6.12) would approach the proportions of such types at Ain Ghazal.

Dihedral platforms at Ain Ghazal in the Middle PPNB are in a similar range to those from coeval sites in Jilat (section 6.8.2; table 6.12). They are only slightly less frequent at Ain Ghazal in the PPNC and Yarmoukian than in the Early Late Neolithic in Jilat and close to the frequency at Late Neolithic Azraq 31. Platform facetting occurs on 2.7% of blade platforms at Ain Ghazal in the Middle PPNB. That is, it occurs with considerably less frequency than at coeval sites in Jilat. At Azraq 31 in the Late PPNB, however, platform facetting is even less important than at Ain Ghazal (section 6.8.2; table 6.12). At Ain Ghazal it is higher in the PPNC, over 4% of blade-bladelets, than in the Middle PPNB and then rises again in the Yarmoukian to c. 8% of blade-bladelets (Rollefson 1990, table 1). In Jilat in the Early Late Neolithic post-dating Early Phase J13 platform facetting is lower than the PPNB, and thus more comparable with coeval Ain Ghazal (section 6.8.2; table 6.12). At Azraq 31, as with so many other attributes, the Late Neolithic continues the Late PPNB tradition in the same setting with platform facetting thus being lower than at Ain Ghazal. Cortical platforms at Ain Ghazal rise in importance from 1.8% of Middle PPNB blade platforms to c. 7% of PPNC and Yarmoukian blade-bladelet platforms (Rollefson 1990, table 3). A clear rise in importance of cortical platforms can be documented at J25 (section 6.8.2; table 6.12). However, as with the proportions of flakes and blades and punctiform+filiform platforms the differences between the other Jilat and Azraq Late Neolithic and the 7th M.b.c. assemblages are minimal. Cortical platforms are much more important at coeval PPNB sites in Jilat than at Ain Ghazal (section 6.8.2; table 6.12). They are slightly more important at coeval Late Neolithic sites in Jilat and at Azraq 31 than at PPNC or Yarmoukian Ain Ghazal excepting J25 (section 6.8.2; table 6.12). At J25 where the pattern of 6th M.b.c. developments at Ain Ghazal finds its closest reflection, cortical platforms are actually much more important than at coeval Ain Ghazal.

The other major development from PPNB to PPNC, a trend which is amplified in the Yarmoukian, is the change in raw material use. There is a shift away from the use of finer and tabular materials imported from an unknown, but possibly relatively distant source, to lower quality alluvial and colluvial cobbles. This is another development mirrored at J25 and possibly also J13 Phase II, although without decrease in quality selected for use in this last setting (sections 6.6.3-6.6.4).

Section 7.1.3 Beidha and Basta.

In southern Jordan there is a sequence of sites in the Beidha and Basta area which span 7th into early 6th M.b.c. developments.

Section 7.1.3.1 Beidha.

At Beidha the Middle PPNB is represented by levels VI-V. IV may be a level with components of earlier and later phases. Levels III-I may represent later developments that could be ascribed to Middle and/or Late PPNB (section 4.2.2). Whilst there are differences in the proportions and character of tool types, particularly points, between earlier and later phases at Beidha (section 4.2.2), any potential differences in technology are unclear given relatively detailed, but preliminary, publication (Mortensen 1970). Mortensen's core types, which are partly related to different reduction strategies, are present in much the same proportions through time, although opposed platform blade cores are somewhat more important in levels VI-IV.

The Beidha core assemblage, which was relatively large, over 1,800 cores, was dominated by a category (Mortensen 1970, 15-16) which included single platform cobble types (Mortensen 1970, fig. 3d), other single platform types, change of orientation types, many irregular cores (Mortensen 1970, fig. 3e) and some hammerstones and sparsely flaked nodules. This category made up c. 80% of Beidha cores. Other single platform core types include pyramidal types which are less than 1% of the Beidha cores. Globular cores, which include change of orientation types, make up just over 4% of cores and discoidal types are just over 2%. Opposed platform blade cores, which probably include a significant proportion of naviform types *sensu lato*, are only just under 6% of cores from Beidha, although a small number of preforms, some of which are related to naviform production, might increase slightly the frequency of representation of this strategy (Mortensen 1970, 15-16). Whilst the precise nature of the dominant category of cores is unclear, but very wide, it is evident that naviform strategies *sensu lato* and opposed platform strategies in general were relatively unimportant compared to Jilat and Azraq in the 7th M.b.c. or to Jericho.

Illustrations (Mortensen 1970, figs 3a, 5 and 6) and limited statements (Mortensen 1970, 15-16) allow some indication of the nature of naviform strategies *sensu lato*. Using tabular flint from Jebel Shara, naviform and sub-naviform tabular edge strategies (Mortensen, fig. 5 upper) were clearly practised. Such cores had no crest opposite the main removal surface, which was prepared by cresting. They are similar to Jericho and Jilat sub-naviform cores. Naviform-tabular and naviform cores have right angle and adjacent crests as in Jilat. Scars on preforms and naviform cores suggest the removal of CxF1 flakes as in Jilat (section 6.7.3) and thus very similar preparation methods for the tabular flint (figs. 6.6-6.8). No Douara type reduction is evidenced, but only a few cores are represented in illustrations. The impression is that the range of naviform reduction strategies was very similar to those practised at coeval Jilat, Azraq or Jericho.

Mortensen presents data of the range of core sizes for his different categories. His most coherent category is clearly opposed platform blade cores represented by a substantial proportion of naviform strategies *sensu lato*. These cores range from 50-136 mm. in length and he estimates, without calculation, have a mean length of c. 70 mm. The range of the lengths of Beidha cores thus overlaps completely with both Jilat/Azraq (sections 6.3.1.3 and 6.5.2) and Jericho cores. Hence there are cores shorter than the bulk of naviforms at Jericho and considerably longer than the bulk of cores from Jilat/Azraq. The mean that he estimates is, however, relatively close to the mean for Jilat and Azraq naviforms (length 67 mm.), which is much lower than that for Jericho naviforms might be. Perhaps the distribution of lengths is likely to be more akin to that from Jilat with lower numbers of longer cores (fig. 6.52). We must be careful, however, given that the average length of Beidha opposed platform blade cores is very approximate. There are clearly a number of very large naviforms at Beidha only exceptionally encountered in Jilat/Azraq; 2 are illustrated in Mortensen 1970, fig. 5 which approach c. 140 mm. in length. Preforms, some of which clearly relate to naviform production, are all over 120 mm. in length (Mortensen 1970, 15-16, and fig. 3a) and this is considerably longer than many related Jilat preforms (section 6.3.1.3, fig. 6.16), although a few are this long (fig. 6.6).

Like Jilat non-naviform 7th M.b.c. cores, most examples of such cores at Beidha are over 50-60 mm. in length (section 6.5.2). These core types include the dominant single platform, change of orientation and irregular types as well as discoidal cores (Mortensen 1970, 15-16). As with the naviforms at Beidha a significant number of these cores are longer than any comparable Jilat core types, including some of the single platform pyramidal and the discoidal flake cores. The group of globular flake cores, which include change of orientation and irregular cores, were clearly distinguished by Mortensen, at least partly, on the basis of their size. They are smaller than all other core classes and appear to be equivalent to the low proportion of cores at Jilat 7th M.b.c. sites with lengths less than 60 mm. (section 6.5.2). Their low proportions at Beidha are clear: they are the only cores less than 60 mm. long and they are only c. 4% of the core assemblage (Mortensen 1970).

Little information relevant to techniques at Beidha is available. Tabular material was available within a few kilometres of the site and some used for naviform cores. Nodular material was more common in the assemblage and used for single platform, change of orientation and irregular core strategies. Degree and precise character of use of each type is unquantified.

Section 7.1.3.2 Basta.

Basta was occupied in the Late PPNB and an Early Late Neolithic from which pottery was absent. Area A has Late PPNB remains and Area B has final PPNB to earliest Late Neolithic deposits. Some of these last must be coeval with the PPNC at Ain Ghazal and Early Late Neolithic in Jilat (sections 4.3.1 and 4.4.4-4.4.6). The upper levels of Area B may be Early Late Neolithic or slightly later. It seems likely that most of the sequence at Basta post-dates most of the sequence at Beidha.

Information about reduction strategies in general is limited, although specific information is available about tabular raw material and naviform reduction strategies. In an early preliminary report (Gebel *et al* 1988, 117), relating mostly to excavations in the Late PPNB levels in Area A, Gebel reported a very high proportion of irregular flake cores, presumably including some change of orientation types, with the presence of other opposed platform tabular edge cores, an illustration of one of which might be a sub-naviform-tabular core in Jilat terms. This account would be pertinent to a situation similar to that at Beidha. On the other hand a later preliminary report (Nissen *et al* 1987, 97-98, table 2) contrasting Areas A and B gives figures which indicate that, at least in some Late PPNB contexts, opposed platform cores, including naviform and opposed platform prismatic types, were more important than single, change of orientation and irregular cores. If irregular cores are excluded in assessing the relationship between opposed platform and single platform + change of orientation types, as they were for Azraq Project sites (table 6.7), then a similar profile of reduction strategies is indicated for at least some contexts in Area A in Basta as encountered in Jilat and Azraq in the 7th M.b.c. (section 6.5.1). In Area B a small sample of cores indicates the dominance of single platform, change of orientation and irregular cores (Nissen *et al* 1987, 97-98, table 2). A situation which is parallel to that in the Early Late Neolithic in Jilat, but not Azraq 31 Late Neolithic (section 6.5.1). In fact, opposed platform cores are so rare reduction strategies would be most akin to those at J25 (table 6.7). A sample of debitage supports this picture derived from the limited sample of cores. In lower Area A at Basta blade-bladelets with indications of opposed platform production outnumber blades with no indication of opposed platform reduction (some of the last which will, of course, derive from opposed platform cores even so) by a ratio of 3:1. In Area B the relationship is reversed and the ratio is 0.5:1. Clearly opposed platform blade-bladelet production declined considerably over the period represented. In the upper levels of the Area B buildings spherical/polyhedric flake cores dominate. These appear to include, irregular, multiple platform and change of orientation cores; in addition there are single platform blade and flake cores. A few opposed platform blade cores still occur in these deposits. The implication is that these last may have disappeared in the occupation post-dating the buildings in Area B (Nissen *et al* 1991, 23-24).

Opposed platform production clearly utilised tabular edge strategies, including some of naviform character. There are illustrated examples that are either sub-naviform-tabular or tabular opposed cores in Jilat terms (Gebel *et al* 1988, fig. 9:1). Other cores have more classic naviform morphology. Tabular edge crests were clearly common. In Area A CxF1 and CxF2 flakes are a significant component of the flake debitage (Nissen *et al* 1987, 97-98, table 2). Tabular edge preparation cresting clearly became much less common in Area B if it was practised at all (Nissen *et al* 1987, 97-98, table 2). The production of ECPs (Nissen *et al* 1991, fig. 2) also attests to tabular edge reduction strategies very similar to those in Jilat (fig. 6.9). No examples of naviform cores akin to those produced by the Douara method have been illustrated. The use of these tabular edge strategies, naviform and possibly other clearly continues the tradition already established in the Middle PPNB at Beidha.

Little information is available relating to sizes of cores from Basta. Naviform and sub-naviform cores illustrated fall into the size range of Jilat naviforms (sections 6.3.2.3 and 6.5.2; fig. 6.52) (Gebel *et al* 1988, fig. 9:1, Nissen *et al* 1987; 1991, fig. 2). Single platform, change of orientation and irregular cores fall in the same size range as similar types in Jilat (Nissen *et al* 1991, 23)(section 6.3.1.3).

Production in Area B had shifted dramatically in favour of flakes. In lower levels in Area A the ratio of flakes to blades was 1:2, in upper levels in A, 1:1.5. In Area B the ratio was completely reversed at 3:1 (Nissen *et al* 1987, 97-98). The frequencies of flakes and blades at Late PPNB Basta is very similar to those in 7th M.b.c. Jilat and Azraq 31 (section 6.7.1; figs. 6.70-6.73). In Area B in the final PPNB or Early Late Neolithic the situation is very similar to that at J25 (fig. 6.77).

There is also some limited information available relating to techniques at Basta. It is suggested that hard hammer percussion was used for flake production in preparing cores from the Late PPNB levels in Area A (Gebel *et al* 1988, 117). This situation is common at other PPNB sites and was probably the case in Jilat and perhaps Azraq 31 (section 6.8.1). Of a sample of blade-bladelet platforms from Basta Area A fully 87% are punctiform (Gebel *et al* 1988). This almost certainly includes filiform platforms and may include platforms which in Jilat sites and Azraq 31 were classed as small plain platforms. As at Ain Ghazal and Jericho it seems likely that punctiform plus filiform platforms were much more frequent than in Jilat in the 7th M.b.c., although the high proportion of very small plain platforms in Jilat suggests that the differences are not quite as dramatic as they might at first appear (section 6.8.2; table 6.12). The importance of punctiform plus filiform and of very small plain platforms at Azraq 31 suggests that this reflection of technique may place Azraq 31 closer to these three Mediterranean zone sites than to Jilat 7th M.b.c. occupations (section 6.8.2; table 6.12). Of other platforms at Basta only 4% were cortical and 2% dihedral (Gebel *et al* 1988). Both these platform types occur in significantly higher proportions on Jilat occupations of the 7th M.b.c. (section 6.8.2; table 6.12). Further facetted striking platforms were absent from this Basta sample, a clear contrast with 7th M.b.c. blade-bladelet platform samples in Jilat (section 6.8.2; table 6.12). Cortex on striking platforms of cores becomes notably more frequent in Area B at Basta (Nissen *et al* 1991, 23). This development is thus similar to that attested by the difference between the 7th M.b.c. production technologies in Jilat and those at J25 and is an indicator of reduced core preparation (section 6.8.2; table 6.12).

One other very clear development is marked in the changes from Area A to Area B. Tabular raw material, whose source is unknown, but located at some distance, dominates raw material in Area A. In Area B local alluvial and colluvial cobbles are used to the complete exclusion of tabular material in upper levels in the Area B building complex and post-dating the buildings. Increasingly poorer quality material was used (Nissen *et al* 1991, 23).

Section 7.1.4 Summary of comparisons between Mediterranean zone sequences and that from Jilat and Azraq.

Opposed, single platform and change of orientation reduction strategies occur with the same relative frequencies at Jericho, and possibly Basta, as in the 7th M.b.c. in Jilat and

Azraq 31 (section 6.5.2 and table 6.7). There are indications in the south, however, at Beidha and possibly Basta, that irregular, single platform and change of orientation cores are considerably more important than at either Middle PPNB Jericho, in coeval Jilat or Azraq 31 (section 6.5.2 and table 6.7).

The precise character of the reduction strategies of which these broad classes are composed suggests considerable similarities exist between the strategies carried out at the Mediterranean zone sites and in Jilat and Azraq 31. This can best be documented in the case of naviform strategies *sensu lato*. The evidence from Jericho, Beidha and Basta suggests that naviform strategies were very similar to those in Jilat and Azraq 31. Further, as far as can be ascertained at this stage of preliminary publication in the case of the last two sites, the Douara method, which characterized production in the 7th M.b.c. at some sites in the northern Levant (Nishiaki 1992), was absent in the southern Levant. Furthermore, the evidence from Beidha and Basta suggests that naviform strategies, adapted to a very particular form of exploitation of the edges of tabular raw material, were identical in the 7th M.b.c. Edomite highlands and Jilat and Azraq.

The proportions of blade-bladelets produced at the 7th M.b.c. occupations seems very similar.

The most significant differences, in terms of reduction strategies, seem to be indicated by the sizes of the naviform cores in some of these Mediterranean zone occupations. At Jericho most naviform cores and at Beidha a significant number of naviforms were bigger than almost any Jilat naviforms (sections 6.3.2.3 and 6.5.2). This does not seem to have been the case for Basta. This seems to indicate that larger preforms were manufactured at Jericho and to some extent Beidha than in coeval Jilat/Azraq 31. The size of preforms in Jilat does not relate to limitations in the locally available raw material that was exploited.

Whilst reduction strategies seem very similar between Jilat and extensive areas of the Mediterranean zone, there are distinct contrasts in the techniques employed. Blade-bladelet platforms indicate very high proportions of punctiform platforms *sensu lato* in 7th M.b.c. occupations at Jericho, Ain Ghazal and Basta. Although the definition of punctiform platforms (including filiform) used at Ain Ghazal and Basta may be very wide, enough information has been provided to indicate that similar platforms do not occur in Jilat with anything like the frequency they do on these sites (section 6.8.2, table 6.12). Further, at Jericho the definitions provided allow of much more precision for comparison and it is quite clear that the contrasts indicated between Ain Ghazal and Basta and Jilat also exist between Jilat and Jericho. Given that platform preparation on the main removal surface is closely related to the isolating of punctiform and filiform platforms, high proportions of these latter almost certainly imply high proportions of the former, as intimated by Rollefson and Abu Ghaneima (1983) and as indicated for Jericho by Nishiaki (1992). We might suspect then that the situation at Jericho is replicated in other areas of the moister zone with high proportions of platforms with preparation of the main removal surface. The distinctions in platform type extend beyond this, however, as indicated by differences in the proportions of cortical, dihedral and facetted platforms between these sites and Jilat. Whilst the differences between the moister zone sites in the 7th M.b.c. and between all 7th M.b.c. sites in Jilat are stark, techniques of blade-bladelet production at Azraq 31, as represented by platforms, appear more akin to those employed at those sites to the west and south west (section 6.8.2, table 6.12). There are still, undoubtedly, differences, cortical platforms, for example, are quite significant at Azraq 31 in contrast to the sites in the moister areas (section 6.8.2, table 6.12). At Jilat, Azraq 31 and Jericho the importance of these punctiform+filiform platform types seems closely tied to the importance of softer hammer/indirect percussion/pressure techniques (section 6.8.3). We may surmise that the importance of this area of the technique spectrum at Jericho is also mirrored at Ain Ghazal and Basta in the 7th M.b.c. There may very well be consequential contrasts with Jilat, where softer hammer techniques had a significant if not dominant role, but harder hammer techniques may also have been important (section 6.8.3).

Clear changes in reduction strategies and technology in general are indicated at the beginning of the 6th M.b.c. by the sequences at Ain Ghazal and Basta. These developments include a change to a clear predominance in flake production, the abandonment of an interest in tabular material procured at some distance and a decrease in selectivity of the alluvial and colluvial cobbles actually used. Also typical is the dramatic decline in the importance of opposed platform production, probably encompassing the disappearance of naviform production and an overall decrease in preparation of cores associated with but not encompassed by this disappearance of naviform production. These transformations appear fully accomplished in the PPNC of Ain Ghazal and the final PPNB or earliest Late Neolithic of Basta. In Jilat these developments all appear together on J25 in the early 6th M.b.c. (sections 6.9-6.10). The two phases of assemblages on J13 do not reflect these changes so completely, however. It has already been argued that J13 Phase I probably represents a Late PPNB-Early Late Neolithic transitional assemblage, based upon the character of the points (section 4.4.5) and presence of low but significant proportions of naviform cores. It seems plausible that J13 Phase I is earlier than J25 on this basis and that we can chart the disappearance of naviform strategies and of a strong interest in tabular raw material at the very beginning of 6th M.b.c. (sections 6.9-6.10). It is the position of the J13 Phase II assemblage which is problematic. If they imply anything, the transverse arrowheads might tempt us to place this assemblage later than that at J25 (sections 4.4.5-4.4.6), but low proportions of transverse arrowheads may not be a good guide. Features of technique (sections 6.8.2-6.8.3), the importance of blade-bladelet production (section 6.7.1-6.7.2), a continued degree of interest in tabular raw material (section 6.6.3) and opposed platform production, and possibly naviform strategies (section 6.5.1), all argue a degree of caution in assuming unilinear, synchronous and uniform changes in the early 6th M.b.c.

It is possible that unilinear, synchronous and uniform chronological developments comparable to those at Ain Ghazal and Basta are a factor in the changes noted between J25 and 7th M.b.c. technology in Jilat. It may be that the evidence of this transformation, which we have preserved in occupations of potentially short time spans in Jilat at the beginning of the Early Late Neolithic, is not absent from Ain Ghazal or Basta. It may be masked merely by the character of the sites where discrete and short episodes, even within the PPNC or Early Late Neolithic, cannot be isolated in the relatively long occupational sequences from such sites.

Whilst it is tempting to explain away the divergences between the pattern of change in the moister zone and in the steppe and desert in this manner, the Late Neolithic at Azraq 31 then remains problematic. On this site, of course, residuals may confuse the issue, particularly amongst the small core sample. The indications from the debitage are clear, the traditions of the 7th M.b.c. are continued in the Late Neolithic at Azraq 31. In particular the localized technique traditions established by the late 7th M.b.c. at Azraq appear to continue (section 6.8.4). More than that blade-bladelet production continues strongly in the Late Neolithic occupation (section 6.7.1). Opposed platform cores completely dominate reduction strategies, although naviform cores are not as important as in 7th M.b.c. occupations (section 6.5.1). Naviform cores in fact occur in similar proportions as on J13 Phase I. Use of tabular raw material persists. However, there is a 'new' interest in poorer quality cobble material in the Late Neolithic of Azraq 31 (section

6.6.3). The persistence of tabular flint as a source may simply be a reflection of the local distribution of raw materials. There are other similarities between J13 Phase I and Azraq 31 Late Neolithic (Baird *et al* 1992) so it may be that the Late Neolithic at Azraq 31 is also very early. Even so it does not have the fully transitional character that the J13 Phase I assemblage seems to possess - this is because of its very high proportions of opposed platform cores (section 6.5.1) and blade-bladelets (section 6.7.1). Turning to the question of residuals the core assemblage may be more suspect, but it seems unlikely that the vast bulk of debitage in the Late Neolithic deposits derives from the volumetrically more limited Late PPNB deposits (Baird *et al* 1992, 24). The case of Azraq 31 argues some caution in assuming that in the early 6th M.b.c. technological change was uniform, synchronous and unilinear.

Section 7.2 Comparisons of technology with other Mediterranean zone sites in the southern Levant

Information relating to chipped stone production technology of other sites in moister settings is of a very limited nature. Final publications are few. Preliminary publications have made only cursory references to technology; in this light it is difficult to build up a systematic picture of variation in technology.

Section 7.2.1. Early PPNB.

Mujahiya.

As section 4 (table 4.2) indicates, discrete Early PPNB occupations are rare. Mujahiya (Gopher 1990) is one of the few recently excavated. As with J7 Phase I it has an assemblage of cores that indicate reduction strategies broadly similar to those employed at PPNA Jericho with the addition of (in the case of Mujahiya) very rare naviform strategies (Gopher 1990, 121-2). Cores illustrated and described (Gopher 1990, 121-2, figs. 6 and 7) comprise significant proportions of single and change of orientation cores including prismatic, pyramidal and cobble types. There is considerable variability within these broad strategies at Mujahiya, as on J7 Phase I (section 6.5.1). At Mujahiya this is indicated by the fact that a significant portion of the core assemblage was difficult to class (Gopher 1990). Most of the Mujahiya cores were relatively small, most of those illustrated were 20-40 mm. long and thus, at least, ended their lives as producers of bladelets. This, as with their size, suggests further similarities with a considerable proportion of the cores from J7 Phase I (section 6.5.2). On the other hand the blade-bladelet:flake ratio is much lower than on J7 Phase I (section 6.7.1). This may be, at least partly, related to the very low proportions of opposed platform and naviform production.

Section 7.2.2. Middle PPNB.

Abou Gosh

Abou Gosh is located in the Judean hills west of Jericho. Raw materials consist mainly of local flint with small quantities of an exotic red (rose-violet) type fine grained material, which is used particularly for points, piercers and burins, a situation clearly analogous to that in earlier J7 Phase I (section 6.6.3).

A very high proportion of cores are irregular and indeed characterized by only a few removals. Of 55 cores which would fall into more regular categories only 1 was naviform (Lechevallier 1978, 42). This indicates a very low proportion of naviform cores, whether the whole assemblage or only more classic types are considered. Other types include small change of orientation pyramidal bladelet cores (Lechevallier 1978, fig. 12:1 and 6) and single platform prismatic blade cores. The high proportions of irregular cores suggest a situation similar to that at coeval Beidha. It is difficult to establish clear comparisons in the absence of well defined classification procedures for cores. The presentation of the data relating to the cores makes it very difficult to establish the proportions of opposed platform cores in the assemblage. The very low proportions of naviforms may be slightly misleading. There are a number of very long, straight crested blades; they range from 88-185 mm. long (Lechevallier 1978, 42 and fig. 12:3 and 4) highly suggestive of large naviform preforms. The only naviform in the core assemblage is broken and so no comment can be made about its size. There is thus at least the possibility at Abou Gosh that, whilst naviform strategies were not as important as in 7th M.b.c. Jilat (section 6.5.1), naviform preforms considerably larger than any in Jilat (fig. 6.16) were utilised, as at coeval Jericho and Beidha.

There are slightly more blade-bladelets than flakes amongst the debitage at Abou Gosh, a situation broadly similar to coeval assemblages in Jilat (section 6.7.1). On the other hand blade-bladelet blanks completely dominate. They amount to just over 90% of the tool assemblage (Lechevallier 1978, 42). The limited number of blade-bladelet cores compared to the frequency of blades in the assemblage and the size of many of the blades compared to the cores, led Lechevallier to suggest (1978, 42) that production may have occurred off-site, or perhaps elsewhere on the site. This may account for a potential under-representation of naviform strategies in the core assemblage. The import of large blades would be reminiscent of the Late PPNB on Azraq 31.

Little information about technique is available but the importance of punctiform and related platforms and diffuse bulbs is indicated (Lechevallier 1978, 42). Unfortunately this information is not quantified.

These hints of the importance of softer hammer techniques and punctiform platforms along with the potential presence of some very large naviform preforms suggest aspects of a production technology similar to Jericho.

Section 7.2.3. Late PPNB.

Beisamoun

At Beisamoun in the Huleh basin excavated deposits were Late PPNB, although occupation on the site may have extended into the Early Late Neolithic.

Little indication of reduction strategies is provided, but naviforms are only 3.6% of the 83 cores from the site (Lechevallier 1978, 154). Opposed and single platform prismatic and pyramidal blade-bladelet cores represent a variety of strategies. Irregular cores are common but classification procedures for cores were clearly limited. Small cores appear to have been in the majority, but a significant proportion of cores over 55 mm. in length were present and include naviform cores (Lechevallier 1978, 154).

The presence of many crested blades between 90 and 120 mm. in length suggests large, possibly naviform, preforms (Lechevallier 1978, 154). The only naviform core illustrated is over 100 mm. long. Potentially a significant number of large preforms were utilised in production for this site. This may be reflected in a number of very long blades, found in a cache near one of the plastered skulls on the site, which were between 80 and 120 mm. long (Lechevallier 1978, 154). Such long blades only occur in any numbers at Azraq 31 in the Late PPNB (section 6.7.2).

The blade-bladelet:flake ratio is 1:2.4 at Beisamoun indicating a low proportion of blades for a 7th M.b.c. assemblage.

Section 7.2.4. Late Neolithic.

Sha'ar ha Golan

There is good reason to believe that Sha'ar ha Golan is early in the Late Neolithic, although it is the type site of the Pottery Neolithic A-Yarmoukian and pottery is thus present. Perhaps pottery occurs earlier in the north, although there does appear to be a PPNC at Tell Eli (section 4.3.3, table 4.2).

Wadi cobbles from the Wadi Yarmouk provided the raw material. It appears that cobble cores are common with only one face of the cobble exploited (Stekelis 1972, 22). It is clear that single platform cobble, prismatic and pyramidal cores are dominant comprising 76% of the core assemblage (Stekelis 1972,22-3 and pls. 19 and 33). Opposed platform cobble and prismatic cores along with what may be sub-naviform cores (Stekelis 1972, pl. 33:1, 35:1) constitute the other 24% of cores. This is reminiscent of the assemblage in J13 Phase II. As with the latter, blade-bladelet cores and blade-bladelets were relatively important. 74% of flakes and blade-bladelets were blade-bladelets, a high proportion smaller elongated debitage (bladelets in Stekelis' terms) (Stekelis 1972, 23).

The reduction strategies and debitage products from this site provide a contrast with coeval Ain Ghazal and probably coeval Basta and provide an indication that in the Mediterranean zone, as in the dry steppe/desert areas we must not assume unilinear and uniform transformations of technology in the 6th M.b.c.

Section 7.3. Arid zone sites.

It seems appropriate to examine in most detail the technologies of arid zone sites closest to those in the centre and south west of the Azraq basin first.

Section 7.3.1. Late PPNB.

Dhuweila

Dhuweila is located in the east of the Azraq drainage system c. 60 km. north east of Azraq 31. It is Late PPNB (section). It is the site closest in time and space to the Late PPNB at Azraq 31. It was excavated by Betts (1988a) an the technology of the chipped stone industries is being studied by McCartney. Information has been taken from McCartney's (1989) M.A. dissertation and from more recent updated data very kindly supplied by her.

Raw material for the chipped stone industry at Dhuweila must be imported from an estimated distance of at least 20 km. (Betts 1988a; McCartney 1989), although no systematic survey has been carried out to confirm this observation precisely. Most of the raw material was tabular.

There are clear indications that reduction strategies possessed many similarities with those practised in Jilat and at Azraq 31. The exception is the occurrence of splintered pieces. It is not clear whether these are cores or tools. If they are cores the debitage provided for tool blanks would be relatively small scale. McCartney (1989, 48-50) considers such as cores, following White (1968). Whether tools or cores they are absent from the assemblages in Jilat or at Azraq. At Dhuweila they are c. 19% of cores.

Naviform and sub-naviform cores appear to make up c. 34% of cores (McCartney 1989, table 5); a significant component of these are naviform-tabular and sub-naviform-tabular cores which are very closely related to the cores of similar type recovered from Azraq and Jilat (personal observation). If the splintered component were not considered the proportion of naviform cores would be close to those documented in 7th M.b.c. Jilat and Azraq (section 6.5.1). Other opposed platform strategies, excluding splintered pieces, which are probably the product of bipolar on anvil techniques, are represented by low proportions of cores, only c. 4%. Single platform and change of orientation cores are each just over 12% of cores. Discoidal cores occur in low proportions, c. 4% and irregular and flake cores make up another 12% (McCartney 1989, table 5). Although non-naviform opposed platform cores occur in low proportions, the importance of opposed platform strategies overall, relative to single and change of orientation strategies, is similar to Jilat and Azraq 31 in the 7th M.b.c. (section 6.5.1).

Few PPNB cores have much cortex at Dhuweila, only 4% of cores have over 30% cortex and over 60% have no cortex (McCartney 1989, table 6). Naviforms in the 7th M.b.c. in Jilat and at Azraq are comparable in that such cores with cortex occur with limited frequency and with low amounts of cortex; non-naviform cores have a very different profile of cortex presence (section 6.3.2.5). This strongly suggests that non-naviforms in Jilat and possibly Azraq were rather different, in this regard, to those at Dhuweila. Furthermore, at Dhuweila only 6% of cores have any cortex on their platforms; this implies that many non-naviform PPNB cores at Dhuweila did not have cortex on their platforms. In Jilat and at Azraq 31 a relatively high proportion of 7th M.b.c. non-naviforms and a small but significant proportion of naviforms have cortex on the striking platform, indicating further differences (sections 6.3.2.5 and 6.3.2.7).

With the exception of splintered pieces reduction strategies may be relatively similar at Dhuweila in the 7th M.b.c. It is possible that the use of reduction strategies and techniques, reflected by splintered pieces, which employ debitage, indicates a maximization of a limited supply of raw material. The relatively high proportions of cores, including non-naviforms, without cortex, may also indicate this.

McCartney (1989, table 7) provides information on core sizes. The mean length of PPNB naviforms from Dhuweila is c. 67 mm. and width 29 mm. The mean length of sub-naviforms is c. 58 mm. and width 21 mm. Other core types are smaller. Single platform, pyramidal and irregular cores have mean maximum dimensions of 43-46 mm. Splintered pieces are smaller with mean maximum dimensions of 38 mm.

The mean dimensions of Jilat naviform cores *sensu lato* (from the sample of 250 cores for which detailed attribute analysis was carried out) is length 67 mm., width 31 mm. and thickness 33 mm. (appendix 2). This includes sub-naviform cores. Naviform cores *sensu lato* from **both** broad periods of occupation at Azraq 31 have means of length: 54 mm., width: 31 mm., and thickness: 26 mm. Whilst this indicates that a number of naviform cores *sensu lato* at Dhuweila are slightly smaller than most naviform cores in Jilat, by the same token they are at least longer than many Azraq 31 naviforms. More significantly, the overall size character of the core groups from these three locales is very similar, especially when compared to many of the larger naviforms found in the moister zone settlements to the west (see above).

Most non-naviform cores from 7th M.b.c. Jilat, amongst which it should be stated opposed platform strategies are predominant, are longer than 50 mm. (section 6.5.2). Late Neolithic non-naviform cores are also relatively large. The mean dimensions of non-naviform cores from J7 Phases II and III are length: 58 mm. width: 37 mm. and thickness: 31 mm. J26 non-naviforms have larger mean dimensions (appendix 2). Clearly many non-naviform cores from Jilat are larger than most non-naviform core from Dhuweila. The sizes of non-naviforms of both periods from Azraq 31 are much more comparable with the sizes of non-naviforms from Dhuweila. Thus, the mean dimensions of the non-naviform Azraq 31 cores are length: 49 mm., width: 32 mm. and thickness: 26 mm. It may be that naviform strategies were subject to a set of specific requirements different from non-naviforms and that the size of Dhuweila and Azraq 31 non-naviforms reflects maximization of raw material in an environment in which it had to be introduced from a distance.

The mean dimensions of blade-bladelet debitage from Late PPNB Dhuweila (comparative data provided by McCartney) are very similar to mean dimensions of blade-bladelet debitage from 7th and early 6th M.b.c. sites in Jilat and at Azraq 31. All occupations, with the exception of J7 Phase III, from the latter sites have complete blade-bladelet mean lengths of c. 31-36 mm., the range in which the mean length of the Dhuweila PPNB blade-bladelet debitage falls. Mean widths and thicknesses are similar. The mean dimensions of the blade-bladelets from J7 Phase III, c. 45 mm. long and 16 mm. wide, reflect the relatively large size of the blade-bladelet debitage from this occupation, although there are not the significant number of very long blades that there are in the PPNB at Azraq 31. Blade-bladelet products seem very similar between 7th M.b.c. Jilat/Azraq and Dhuweila.

Revised information on blade-bladelet platforms (provided by McCartney) allows fairly direct comparisons of technique between Azraq/Jilat and Dhuweila to be made. Azraq 31 PPNB, the occupation closest in time and space to Dhuweila, has the most similar range of technique indicators. There are similar proportions of cortical, plain and dihedral platforms (section 6.8.2, table 6.12). If McCartney's punctiform platforms can be taken to include filiform types, as their dimensions suggest, then the proportions of this group of platform types are almost identical, 36.81% at Dhuweila, 39.6% at PPNB Azraq 31 (section 6.8.2, table 6.12). Just under half of the plain platforms from Dhuweila are very small, 19.42% of the total platforms and probably, as with very small plain platforms at Azraq 31 (Baird *et al* 1992), very closely related to punctiform and filiform types. The proportion of such diminutive plain platforms is higher at Azraq 31 (figs. 6.104 and 6.106); the situation of such at Dhuweila is more similar to platforms in 7th M.b.c. Jilat assemblages. Crushed platforms, 1.74% of Dhuweila blade-bladelet platforms, are also low at Azraq 31, but much higher in Jilat (section 6.8.2, table 6.12). Whilst platform facetting is rare on Azraq 31 PPNB platforms compared to Jilat, it is even rarer on those from Dhuweila where it is only 0.01% (section 6.8.2, table 6.12). Preparation of the platform edge on the main removal surface is common at Dhuweila c. 46%, although not as common as at Jericho (section 6.8.2, table 6.12) and possibly other Mediterranean zone sites (see above). Of all the sites in the Jilat/Azraq sequence Azraq 31 Late PPNB has the closest indications of a similar degree of such preparation, c. 35% (table 6.12). Jilat sites have much less (section 6.8.2, table 6.12).

Dhuweila PPNB blade-bladelet platforms are small with a mean width 5.5 mm. and a mean thickness only 0.5 mm. Most Jilat 7th M.b.c. platforms are wider and all are thicker (section 6.8.2; figs. 6.108-6.123). The mean widths of J26, J7 II and III platforms are c. 6.5 mm. and the mean thicknesses 2.5-3 mm. At J32 the mean width of platforms is only c. 5.3 mm., much closer to that at Dhuweila. Azraq 31 PPNB platforms are narrower (fig. 6.104) as indicated by a mean width of only 4.3 mm., but mean thickness is considerably greater, 1.4 mm. (fig. 6.106) Platform size indicates that Azraq 31 and J32 are more closely related to Dhuweila in terms of technique than the other Jilat occupations.

The relative importance of harder or softer impactor areas of the technique spectrum are difficult to gauge. Lips occur on fully 52% of blade-bladelet platforms at Dhuweila (data supplied by McCartney) probably indicating the dominance of softer hammer techniques. Impact features (which include ring cracks and crushing) on platforms are quite frequent, c. 41%, but it is difficult to know how precisely these features might correlate with harder hammer use. Diffuse bulbs occur with a frequency similar to that of lips, c. 48% (McCartney 1989, table 15) supporting the dominance of softer hammer techniques. McCartney (1989, table 15) indicates the proportion of concentrated bulbs. How closely these correlate with prominent bulbs in the Azraq Project analysis is difficult to say, but this indicator used on its own proved to be suspect in the Azraq Project analyses. The proportion of lips are much higher than in Jilat 7th M.b.c. assemblages except J32 (table 6.12) and more akin to Azraq 31 Late PPNB which, however, has higher proportions. The possibly significant role for harder hammer techniques in blade-bladelet production is more akin to Jilat (section 6.8.3).

In terms of technique it appears that Dhuweila may be more akin to its neighbouring steppe/desert PPNB sites than to those in the moister areas further west, where punctiform platforms *sensu lato* and softer hammer techniques may be much more important. In particular, in strategy related indices, as well as technique, the similarities between Azraq 31 and Dhuweila production technology are quite notable.

A number of other PPNB sites have been encountered in the *harra* and undergone survey or limited excavation. They include Ibn el-Ghazzi (Betts 1989), Burqu' 35 and a number of survey sites (Betts 1982, 1986). Information relating to the production technology of these sites is limited, however. Preliminary indications are that naviform strategies were not common, if indeed present, at Burqu' 35 (McCartney pers comm.). The only survey sites to yield much material, which can certainly be ascribed to the PPNB or earliest

Early Late Neolithic (on the basis of associated points and the cores themselves), were a series of locales in Qa'a Mejalla site 14, which yielded a number of naviform and sub-naviform cores (Betts 1982, 27). Qa'a Mejalla is located c. 36 km. east of Azraq. These cores include classic naviform-tabular and sub-naviform-tabular cores that would not be out of place in Jilat or Azraq assemblages of the 7th and early 6th M.b.c. Very similar strategies were practised by groups on the east as well as west sides of the Azraq basin. The size of those cores, which are illustrated (Betts 1982), fall mostly at the upper end of the range for Jilat and Azraq naviform cores. One must consider the possibility that the survey recovered only the larger, and therefore, more obvious items or that Betts has chosen to illustrate only the most classic. It may, however, be that these distinctions in size are a further indication of regional variations in production technology in the Azraq basin.

Late Neolithic.

A later phase of occupation(s) at Dhuweila, stage 2, belongs to the latter part of the 6th M.b.c. and an occupation at Jebel Naja may be assigned to the mid-late 6th M.b.c. Detailed technological information is available for both these Late Late Neolithic sites.

Section 7.3.2. Jebel Naja.

Jebel Naja is located just under 70 km. north east of Azraq 31. Raw material was available locally in some quantity (Betts 1986, 205). Cores illustrate the nature of the reduction strategies. Opposed platform cores are uncommon and form only c. 8.5% of the assemblage (McCartney 1989, table 5). Single platform, change of orientation and irregular cores for flakes, including prismatic and pyramidal types, make up the bulk of the assemblage. Discoidal cores are present in significant numbers. Irregular cores appear to be by far the most important (McCartney 1989, table 5). These suggest strategies most akin to earlier J25 and quite distinct from strategies represented at J13 in either phase (section 6.5.1). High proportions of these Jebel Naja cores had cortex on the platforms, c. 38%, most in considerable amounts (McCartney 1989, table 6). Cortex was common on the bodies of Jebel Naja cores. It occurs in significant, but varying degrees which are a good reflection of the occurrence of cortex on Late Neolithic cores in Jilat on both J13 Phase II and J25 (figs. 6.2:1 and 6.3). There is probably a greater frequency of higher degrees of cortex occurrence in Jilat. This is probably related to the importance of tabular and cobble strategies (section 6.5.1) as opposed to the irregular strategies at Jebel Naja. Unfortunately, no core dimensions for J13 Phase II and J25 are currently available, the occupations with which it would be most appropriate to compare the Jebel Naja cores. However, the Jebel Naja assemblage, as with that of Dhuweila 2, is clearly later than the Early Late Neolithic assemblages in Jilat. The absence of splintered pieces is notable given their importance at PPNB and Late Neolithic Dhuweila and in some 6th M.b.c. occupations at Burqu' (see below) on the other, eastern, edge of the *harra*.

The relative frequency of blade-bladelets and flakes at Jebel Naja, c. 75% flakes, (McCartney 1989, table 4) closely reflects the situation at J25 (section 6.7.1; fig. 6.77). The mean dimensions of the complete blade-bladelets from Jebel Naja (McCartney 1989, table 14) seem comparable to those from the Late Neolithic occupations in Jilat and Azraq 31.

The profile of platform types at Jebel Naja is very reminiscent of J25 with very low proportions of punctiform/filiform platforms (McCartney 1989, table 10), similar proportions of facetted and dihedral platforms and of cortical platforms, c. 22% (table 6.12)(McCartney 1989, table 11), although these platforms belong to all blank types and not just the blade-bladelets of the Jilat/Azraq samples. The mean widths and thicknesses of blade-bladelet platforms on Jebel Naja (McCartney 1989, table 13) are more like the means of blade-bladelet platform dimensions at J25 than any other Jilat or Azraq occupations, although the J25 means are somewhat lower at c. 8.5 mm. mean width and c. 3.9 mm. mean height, than those of Jebel Naja platforms. There are more large platforms in the J25 assemblage than any other Jilat/Azraq assemblage, although those from J13 Phase I approach those from J25 in frequency of large platforms (section 6.8.2; figs. 6.122 and 6.123).

Preparation of the platform edge on the removal surface seemed much higher at Jebel Naja than J25 or indeed any Jilat/Azraq occupation (section 6.8.2, table 6.12)(McCartney 1989, 83). Lips are very frequent on Jebel Naja platforms, fully 70-90%. If this is an accurate observation it suggests the absolute dominance of softer hammer techniques and contrasts markedly with J25 where lips occur on only c. 20% of platforms (section 6.8.2, table 6.12). The contrast in the occurrence of this attribute is also marked with any other Jilat/Azraq occupation (section 6.8.2, table 6.12). Diffuse bulbs are, however, only c. 42% of Jebel Naja blade-bladelet bulbs indicating the probable importance of softer hammer techniques, but not necessarily the dominance suggested by the proportion of lips. In the Late Neolithic of Azraq or Jilat only the Azraq 31 occupation has comparable proportions of diffuse bulbs which seem there, at least, to correlate well with the importance of softer hammer use (sections 6.8.2-.3, table 6.12). In Jilat both J13 II and J25 have relatively low proportions of diffuse bulbs, c 21%, the lowest of any occupation in Jilat (section 6.8.2, table 6.12). The general evidence for the significant role of harder hammer techniques at J25 contrasts this occupation with Jebel Naja in terms of techniques (section 6.8.3).

Section 7.3.3. Dhuweila 2.

The most dramatic feature about the Dhuweila 2 core assemblage is the very high proportion of splintered pieces, if they are cores (McCartney 1989, table 5). Irregular, single platform and change of orientation cores for flakes are as important as splintered pieces and obviously dominate completely if splintered pieces are not considered as cores. Opposed platform examples are not important, but include a number of naviform and sub-naviform examples that, given the later 6th M.b.c. date of the assemblage, are almost certainly derived from the underlying PPNB deposits which were partially disturbed in the Late Neolithic (Betts 1988a). With the exception of splintered pieces, broad reduction strategies may not be very different from those practised at Jebel Naja. The low proportions of cortex on platform and body of Dhuweila 2 cores might suggest, as with the high proportion of splintered pieces, maximization of raw material use, partly because of the contrast with Jebel Naja in this regard (McCartney 1989, table 6). The mean maximum and minimum dimensions for each of the core types at Dhuweila 2 are lower than the mean dimensions for each of the core types at Jebel Naja which might support this interpretation (McCartney 1989, 63 and table 7). As in the PPNB splintered pieces are the smallest types in the core assemblage, at least partly because they utilize debitage.

Flakes are a significantly lower proportion of the flake and blade-bladelet debitage at Dhuweila in the various Late Neolithic Phases there. They range from 55-65% of such debitage in each stage (McCartney 1989, table 3). This is significantly lower than coeval or slightly earlier Jebel Naja. Mean dimensions of blade-bladelets from stage 2 Dhuweila are in a similar range to those of Jilat.

Platform proportions are based on flake and blade-bladelet debitage samples so comparison must be circumspectly effected. Punctiform and filiform platforms occur in low but significant proportions, c. 9% (McCartney 1989, table 10). This may, of course, be a result of the presence of residual material. Dihedral platforms occur as c. 8% comparable to the occurrence of dihedral platforms on blade-bladelets from J25 and J13 Phase II (section 6.8.2, table 6.12). Dihedral platforms are much less frequent than such from Azraq 31 Late Neolithic (section 6.8.2, table 6.12). Platform facetting occurs on c. 4% of platforms. This is comparable to J25 but more important than Azraq 31 Late Neolithic (section 6.8.2, table 6.12). Cortical platforms occur on only c. 12% of debitage from Dhuweila 2 (McCartney 1989, table 11), significantly lower than on J25 and more comparable to their occurrence on other Jilat and Azraq Late Neolithic blade-bladelet assemblage platforms (section 6.8.2, table 6.12). Preparation of the platform edge on the main removal surface is very frequent, 50-75% (McCartney 1989, 84), which is very much higher than any Jilat/Azraq Late Neolithic occupation and in particular dramatically higher than J25 (section 6.8.2, table 6.12). Mean dimensions of Dhuweila 2 blade-bladelet debitage platforms (McCartney 1989, table 13) are low in comparison to those of Late Neolithic Jilat, but higher than those of Late Neolithic Azraq 31. Lips occur on a high proportion of platforms (McCartney 1989, 84), between 25 and 50%, suggesting a significant, but not necessarily dominant, role for softer hammer production techniques. This frequency of lips is greater than that encountered on any Jilat Late Neolithic occupation analyzed (section 6.8.2, table 6.12), but not higher than on the Late Neolithic blade-bladelet debitage from Azraq 31 (section 6.8.2, table 6.12). Diffuse bulbs occur on c. 48% (McCartney 1989, table 15) of blade-bladelets again suggesting the importance of softer hammer techniques. They are considerably higher than on Jilat Late Neolithic blade-bladelets, but occur with about equal frequency on such debitage from Azraq 31 in the Late Neolithic (section 6.8.2, table 6.12).

Section 7.3.4. Burqu' Sites.

Located 150 km. north east of Azraq the Burqu' sites have been the object of a very recent project (Betts *et al* 1990). Only preliminary information is available about the chipped stone technology of the series of Late Neolithic sites discovered there. The technology of the assemblage from Burqu' 27 has been reported in some detail. This site has a series of phases, the latest of which may post-date the 6th M.b.c. Dates from Phases 1 and 2 indicate that these phases represent occupation in the second half of the 6th M.b.c. (McCartney 1992, 37) - the Late Late Neolithic (section 4.3.1 and 4.3.3). However, components in Phase 1 may belong to the Early Late Neolithic in the first half of the 6th M.b.c. as well (McCartney 1992, 37).

Pebble raw material of limited size was available in the immediate environs of Burqu' 27, but larger and better quality material was available at no great distance in the limestone *hamada* to the east of the site (McCartney pers comm. and 1992, 50.). Reduction strategies appear to have been adapted to the use of the immediately available raw material (McCartney 1992, 49) of limited quality. Cores form very high proportions of the assemblages indicating limited production from each piece (McCartney 1992, fig. 17). Single platform, change of orientation and irregular strategies clearly dominate. Opposed platform cores are infrequent, although perhaps significantly, given an early component to Phase 1, they are most important in Phase 1 at 11% (sample size is very small, however)(McCartney 1992, figs. 20 and 21). Flake cores are very important and splintered pieces occur in low but significant proportions. The range of mean maximum core sizes indicates the small size of many of the cores c. 20-60 mm.

Flakes completely dominate the flake and blade-bladelet debitage, to an extent not witnessed on other sites discussed here ((McCartney 1992, fig. 17) which McCartney relates to the limited size of the raw material used.

Cortical platforms are very frequent on debitage (flake and blade-bladelet) and occur in greater proportions than at any Jilat or Azraq occupation or indeed on other Late Neolithic sites from the *harra*, which are discussed. Platform facetting is much more frequent, c. 14-15%, than any of the Jilat/Azraq (section 6.8.2, table 6.12) or indeed Jebel Naja/Dhuweila Late Neolithic assemblages. In this respect the contrasts with Late Neolithic Azraq 31 are dramatic (section 6.8.2, table 6.12). Clearly, very different approaches to core/platform preparation obtained. Data is not provided by McCartney, but she suspects that harder hammer percussion techniques dominated (McCartney 1992, 49). This would, also, seem to contrast with Jilat/Azraq (section 6.8.3), Jebel Naja and Dhuweila 2 Late Neolithic assemblages where softer hammer use is moderate to important.

Technology of Neolithic sites from other areas of the arid zone in the southern Levant

Information on chipped stone technology from excavated PPNB sites in the Hisma, Negev or Sinai is currently meagre in the absence of detailed final publications of excavations.

At the Early PPNB site of Jebel Queisa 24 naviform strategies are attested and the importance of bladelets is indicated (Henry 1988). This would accord with the evidence of J7 Phase I.

Section 7.3.5. Nahal Divshon.

Nahal Divshon is located in the central Negev. The bulk of the occupation(s) are probably Middle PPNB (section 4.3.3, tables 4.2 and 4.3).

Opposed platform strategies represent the single most significant type of cores, c. 26% of cores (Servello 1976, table 12-3). These include naviform and sub-naviform types (Servello 1976, fig. 12-4:g and h). On the other hand single platform cores are almost as important at c. 24.5% of cores. When it is appreciated that various types of change of orientation cores make up a further c. 7% of cores, it can be seen that, unlike 7th M.b.c. Jilat assemblages (section 6.5.1, table 6.7), single platform and change of orientation cores outnumber opposed platform cores. Servello has a high proportion of indeterminate or broken cores in his assemblage and, therefore, the relative importance of cores of each determinable type is probably underestimated. Opposed platform cores thus approach proportions in which they are recovered in coeval assemblages in Jilat (section 6.5.1, table 6.7).

As in Jilat and Azraq assemblages (section 6.3.1.4; fig. 6.22) opposed platform cores at Nahal Divshon have more variable platform angles and amongst the lowest platform angles of any core class (Servello 1976, 355). In this regard opposed platform strategies appear similar and probably reflect the importance of naviform strategies *sensu lato* amongst Nahal Divshon opposed platform cores. Opposed platform cores (probably including significant numbers of naviforms) are small (short) by the standards of Jilat. Mean length is only 57 mm. (Servello 1976, table 12-4), mean width is c. 35-46 mm. This is shorter than mean lengths of naviform cores from Jilat but similar to those from Azraq 31. These Divshon cores have greater mean widths, however. The range of opposed platform core lengths indicates that the significant proportion of Jilat and Azraq 31 opposed platform cores over 74 mm. long (fig. 6.18) do not find any parallel at Divshon (Servello 1976, table 12-4). As in 7th M.b.c. Jilat non-naviform cores could be quite large; length ranges extending up to 90 mm. (section 6.5.2). Ranges of various types indicate that a significant number of single platform and change of orientation core types did not exceed 60 mm. in length (Servello 1976, table 12-4). Mean lengths of Divshon non-naviform cores (Servello 1976, table 12-4) are significantly lower than those from 7th M.b.c. Jilat occupations, but more comparable to those from Azraq 31 (see above). Mean widths indicate a significant component of wider non-naviform cores at Divshon than at Jilat or Azraq 31 in the 7th M.b.c.. As in Jilat and at Azraq change of orientation cores appear to be less elongated and perhaps more often have greater widths than single platform cores (figs. 6.17 and 6.19), a clear reflection of the different nature of the strategies involved.

Flakes are slightly more important than blades in the Divshon assemblage. They form 56% of combined flakes and blade-bladelets (Servello 1976, table 12-1). Given the importance of blade production indicated by cores and tool blanks, it is likely that the importance of flakes derives from core preparation as in some coeval assemblages in Jilat (J7 III and J26, section 6.7.3)(Servello 1976, 353). The mean length and width of blade-bladelets is high (Servello 1976, 353), higher than most assemblages in Jilat and Azraq 31 and most comparable with the assemblage from J7 Phase III with its high proportion of large blades (section 6.7.2).

Blade-bladelet platforms at Divshon (Servello 1976, table 12-2) include few cortical platforms. They occur with much lower frequency than in coeval Jilat assemblages. Dihedral platforms are much more important at Divshon (Servello 1976, table 12-2) than in any coeval Jilat occupations (section 6.8.2, table 6.12) or indeed most 7th M.b.c. blade-bladelet platform assemblages. Divshon is one of the few sites where facetted blade-bladelet platforms occur in similar proportions to their proportions in coeval Jilat occupations (section 6.8.2, table 6.12). Lips were uncommon on blade-bladelet platforms at Divshon, less than 16% (Servello 1976, 353) and thus much lower than in any coeval Jilat, never mind Azraq 31 assemblages (section 6.8.2, table 6.12). This would suggest that softer hammer techniques may not have been as important or were of a particular nature, contrasting them with those practised in Jilat (section 6.8.3), or indeed at many other 7th M.b.c. sites.

Section 7.4. Northern sites.

It seemed appropriate to compare Jilat and Azraq technology in detail only with sites in the more southerly steppe zones of the northern Levant, that is those sites in greatest proximity to those in the northern part of the south Levantine steppe. Only two Neolithic sites have enough information about their technology to make comparison worthwhile; PPNB Douara Cave level II (Nishiaki 1992) and Late PPNB and Early Late Neolithic Bouqras.

Section 7.4.1. PPNB Douara Cave and Palmyra basin Locality 35.

Douara cave and Locality 35 are situated in the Palmyra basin c. 350 km. north east of Azraq. The PPNB at these sites cannot be effectively assigned to a period, although Nishiaki (1992, 162) suspects that the PPNB at Douara cave II may belong to the final PPNB of the early 6th M.b.c.

As described above naviform strategies at Douara cave II conform to a distinct method now called the Douara method (Nishiaki 1992, 147-8) which Nishiaki also identified at Middle PPNB Abu Hureyra (Nishiaki 1992, 162). This peculiar naviform strategy, therefore, seems to characterize some areas of the north east of the northern Levant, at least in the 7th M.b.c. As I have indicated, the Douara naviform strategy appears to be absent from the Jilat/Azraq sites (section 7.1.1.2 and 7.1.4), and, as far as I can ascertain absent from any other site in the southern Levant. Naviform strategies dominated the Douara core assemblage to a remarkable degree; fully c. 83% of cores are naviform or sub-naviform. Single platform, change of orientation and irregular cores make up the rest of the core assemblage in about equal proportions (Nishiaki 1992, 119-120). Whilst a particular pattern to the progress of flaking characterizes the Douara method, the location and character of crests on cores suggest that preforms may have had a similar variety of morphologies to those found further south (Nishiaki 1992, 120-3, and fig. 4.7).

Mean naviform core size is higher than that of cores in Jilat or Azraq 31 with mean lengths of c. 75 mm., width: 36 mm., and thickness: 34 mm. (Nishiaki 1992, fig. 4.2). Longer naviforms are certainly present with the range extending to 105 mm., but clearly there would be much overlap in the size of cores from Douara and Jilat. That the mean dimensions reflect the greater size of a greater proportion of naviform cores is indicated by the illustrations (Nishiaki 1992, figs. 4.6-4.9) where most naviforms are over 80 mm. long. This situation that would not be encountered in Jilat/Azraq (section 6.3.2.3; fig. 6.52). Naviform width relates to preform thickness. Whilst it is not clear, but in some cases likely, that greater naviform lengths may indicate larger preforms, more wider naviforms clearly indicate thicker preforms. That naviform preforms far larger than any, probably or actually (section 6.3.2.3, figs. 6.6-6.8; 6.16; 6.52), produced in Jilat, were created in the Palmyra basin in the PPNB, is indicated by the preforms from Locality 35. Here preforms were recovered which reached 300 mm. in length (Nishiaki 1992, 122) and were regularly over 100-150 mm. long and 40-60 mm. thick (Nishiaki 1992, fig. 4.5:1-3, Akazawa 1979). At Jilat a cache of the biggest naviform preforms are c. 140 mm. long (figs. 6.6-6.8).

That such high proportions of naviforms do not occur merely at Douara in the north is also indicated by Abu Hureyra (Nishiaki 1992) and Qdeir (Calley 1986b). In the Middle PPNB sample from Abu Hureyra, studied by Nishiaki, naviforms are c. 72% of cores (Nishiaki 1992, fig. 4.12). At Qdeir they are c. 75%. These proportions, on both short term steppe occupations or long term settlement sites, contrast markedly with the situation on southern sites. In the south the highest proportions of naviforms on 7th M.b.c. sites are just over 40% of cores, whether in steppic Jilat (section 6.5.1) or moister zone Jericho. At some permanent settlements in the Palestinian hill zone or the Edomite hills naviforms occur in very low proportions indeed (sections 7.1.3.1 and 7.2.2). The contrasts in the precise character of naviform strategies between north and south Levant are reflected also in the overall importance of naviform production. It is apparent that it is considerably less important at all southern sites than at some northern sites. Further, at Qdeir large naviforms are relatively important, mean naviform length is 84 mm., width 47.3 mm. and thickness 31 mm. (Calley 1986b, table 2). These mean dimensions are considerably greater than the means of the same dimensions for the Jilat and Azraq naviforms.

Blade-bladelets at Douara cave II are 53.60 % of flake and blade-bladelet debitage and would be even more important if the blanks were included (Nishiaki 1992, fig. 4.9). Clearly blade-bladelet production closely matches that of 7th M.b.c. sites in the southern Levant. A relatively high proportion of blade-bladelets from Douara cave II were relatively long and wide compared to blade-bladelets from Jilat/Azraq 7th M.b.c. assemblages (Nishiaki 1992, fig. 4.15) (section 6.7.2). That is to say, the bulk of blades, not including Nishiaki's sword shaped blades (mostly of Jilat bladelet size), were between 40 and 70 mm. long and 15 and 25 mm. wide. Presumably, as at Jericho, the higher proportion of longer blades must, at least partly, be related to the abandonment of naviforms whilst still large and the potentially greater size of most naviform preforms from these sites compared to Jilat/Azraq.

Platform types (Nishiaki 1992, fig. 4.14) of Douara cave II blade-bladelets indicate notable differences between this assemblage and 7th M.b.c. blade-bladelet platforms at Jilat and

Azraq 31 (section 6.8.2, table 6.12). In particular cortical, facetted and dihedral platforms are much less frequent than in Jilat samples. Even though dihedral and facetted platforms are less important at Azraq 31 than Jilat, they are considerably more important than at Douara cave II (section 6.8.2, table 6.12). Punctiform platforms are more important in Jilat, but filiform are less important than at Douara cave II (section 6.8.2, table 6.12). At Azraq 31 in the PPNB, filiform occur with similar frequency and punctiform are more frequent (section 6.8.2, table 6.12). Both types considered together are thus more frequent at Azraq 31 and of a similar range of frequencies at Jilat 7th M.b.c. occupations in comparison to Douara cave II. In this manner Douara cave II, as with Jilat, contrasts notably with coeval occupations in moister areas of the southern Levant. Preparation of the main removal surface adjacent to the platform is much more frequent at Douara cave II, c. 83 % (Nishiaki 1992, fig. 4.14) than in Jilat, or even at Azraq 31 (section 6.8.2, table 6.12). Further, unlike these sites, grinding is the clearly predominant form of preparation. It is unclear precisely which criteria Nishiaki (1992, 108-110) used to identify presence of softer or harder hammer techniques and, therefore, direct comparison with Jilat/Azraq evidence is not possible. However, Nishiaki does suggest a high degree of softer hammer use for blade production (Nishiaki 1992, fig. 4.6). This makes it unlikely that the number of stigmata relating to harder hammer use identified on Jilat or even Azraq 31 PPNB debitage (section 6.8.3) could be present at Douara cave II. He indicates both soft and hard hammer flake production. In this degree of softer hammer use Douara cave II compares quite well with the settlement sites of the moister areas of the southern Levant.

Section 7.4.2. Bouqras.

Located 525 km. to the north east of Azraq, although in a broadly arid zone, Bouqras was a major permanent settlement because of its riverine setting. The sample of chipped stone studied comes from a sequence, the bulk of which is well dated to the Late PPNB. The uppermost levels of this sequence may well be assigned to the earliest 6th M.b.c., however. The whole sequence was aceramic (Roodenberg 1986, 5). Surface material may well derive from slightly later 6th M.b.c. occupation attested elsewhere on the site.

A low proportion, 13.79%, of a small sample of Bouqras cores (Roodenberg 1986, 12-13 and figs. 5, 7 and 8) were naviform or sub-naviform, the latter predominated. Single and opposed platform prismatic cores dominate the assemblage. Irregular cores make up the bulk of the rest of the assemblage. Occasional preforms and single platform pyramidal cores also occur. Opposed platform cores outnumber single platform cores by a notable degree as with 7th M.b.c. assemblages in Jilat and Azraq (section 6.5.1). Clearly, however, naviform cores do not dominate all northern assemblages.

Conical blade-bladelet cores, clearly the product of pressure flaking (Tixier *et al* 1980, 57-59), also occur (Roodenberg 1986, 13 and fig. 8:4-7). Several of these are obsidian bladelet cores. They are exactly the type of core that would have produced the obsidian bladelets from J13 (section 6.6.5; fig. 4.5:1, 2, and 6) (as opposed to any of the obsidian from J7). 2 of these cores attest production in flint of very large regular blades with facetted platforms (Roodenberg 1986, 13 and fig. 8:4). These large blade cores were recovered on the surface and thus could belong to either early or mid 6th M.b.c. occupations. Of course, they could even belong to a later occupation, but there is no evidence of such on the site and technically they are closely related to their smaller obsidian counterparts. They are exactly the sort of cores from which the Jilat blades (sections 4.4.5, and 8.12.7; fig. 4.6) could have been produced by pressure - possibly even using a crutch and vice (Barnes 1947), as is plausible for Canaanean blade production (Baird 1987). They are c. 220 mm. long and produced very regular trapezoidal blades from the full length of the core, of the order of 17 mm. wide. This may lend credence to the likelihood that these Jilat blades are in fact Late Neolithic (section 4.4.5).

The bulk of naviforms of the published Bouqras sample are illustrated (Roodenberg 1986, figs. 7:1, 2, 4 and 5 and 8:1 and 3). They all range from over 80 to well over 100 mm. in length and most are c. 40 mm. in width. It appears that many naviforms from Bouqras were larger than most from Jilat/Azraq (section 6.3.2.3 and fig. 6.52). Large crested blades (Roodenberg 1986, fig. 8:8 and 9) are well over 100 mm. long. Whilst these are not necessarily related to naviform production they illustrate the potential size of preforms. The bulk of bladelet and flake cores are less than 60 mm. long, these include a range of morphologies amongst which opposed platform types are rare. Blade cores and cores for flakes, which include a number of opposed platform types (Roodenberg 1986, 13), are mostly over 60 mm. in length (Roodenberg 1986, fig. 6). It appears that opposed platform cores are probably longer than most single, change of orientation and irregular types. Unlike the situation in Jilat in the 7th M.b.c. (section 6.5.2), a high proportion of non-naviform cores are less than 60 mm. long.

In levels 10-3 at Bouqras blade-bladelets consist of c. 60-65% of total debitage. It is clear that they are very important relative to flakes, in a manner similar to the bulk of 7th M.b.c. assemblages. In levels 1 and 2 flakes rise to c. 55% of the debitage assemblage (Roodenberg 1986, 19-21 and fig. 4A). A shift in the production of debitage types appears to occur, presumably, given the dates from the Bouqras sequence (Roodenberg 1986, 5), to be assigned to the end of the 7th M.b.c. and the beginning of the 6th. This is clearly analogous to the contemporary shifts in the frequency of the different debitage types documented at Ain Ghazal, Basta and also suggested by J25 (section 7.1.4). Frequency distributions of blade-bladelet length (Roodenberg 1986, 19-21 and fig. 10A) indicate that, contemporary with the increase in the proportions of flakes amongst the debitage, is a decrease in the proportions of longer blades and wider blades. Whilst there are more longer blades in some 7th M.b.c. assemblages in Jilat (J7 II and III) and at Azraq 31, than in those of the Early Late Neolithic, this is not true of all 7th M.b.c. assemblages (J26) (section 6.7.2). Further, although Early Late Neolithic assemblages seem to lack significant proportions of the longest blades found in some of these 7th M.b.c. assemblages, they do have significantly higher proportions of blades over 50 mm. in length than in the Bouqras sample (section 6.7.2). The importance of blade-bladelets 20-30 mm. long in both blade-bladelet assemblages at Bouqras (Roodenberg 1986, 19-21 and fig. 10A) matches the importance of this group in the Jilat assemblages.

No data is available from Bouqras in relation to platform treatment and technique. Valuable data document a change in the use of raw materials. Material of fine quality flint was imported over a distance of at least 30 km., according to Roodenberg (1986, 6), in addition local fluvial pebbles from the Euphrates terraces were employed. Concomitant with the increase in the proportion of flakes in final levels at Bouqras is a clear increase in the proportion of local fluvial pebble material used. This is reflected in all debitage categories, particularly the now dominant flakes (Roodenberg 1986, 205 and fig. 9). In blade-bladelet categories this material increased to c. 50% and much more in the flake categories (Roodenberg 1986, fig. 9).

Section 7.5. Summary of the comparative status of production technologies in the Levantine PPNB and Late Neolithic.

This survey of chipped stone production technology allows certain insights into patterns of behaviour and developments in those patterns through time. In the 8th-7th M.b.c. there are indications that efforts were made to secure desired material. This was better quality material and/or material particularly suited to opposed platform, particularly naviform production (section 6.3.2.8). The evidence of J25, J13 Phase II, Azraq 31 Late Neolithic (section 6.6.4), Basta, Ain Ghazal (sections 7.1.2 and 7.1.3.2) and Bouqras (section 7.4.2) is that this ubiquitous behaviour underwent a widespread change associated with a decline in opposed platform production and the rapid disappearance of naviform production in the early 6th M.b.c., at least in the southern Levant. Where there is evidence, for example the Jilat sequence, Ain Ghazal, and Basta, there are indications of less selectivity in the procurement of the most immediately available material.

Single platform, change of orientation and irregular core related strategies come to dominate in the 6th M.b.c. The evidence from Jilat is that these strategies favoured the use of alluvial/colluvial cobble rather than tabular material (sections 6.6.3-6.6.4). These strategies are all, in some cases very well, represented in 7th M.b.c. production. 6th M.b.c. production appears to represent a continuance of earlier production strategies with a decline in emphasis on opposed platform production and the disappearance of naviform production. Naviform and related opposed platform strategies appear to have represented a relatively high degree of investment to achieve particular products (section 6.3.2.7 and 6.5.4). This is evidenced, not just by potential extra investment in procurement, even in Jilat (section 6.6.3-.4), but by the time and skill invested in the relatively elaborate preform preparation, and in platform preparation and maintenance, compared to other core types. It seems likely that specific techniques and skill were invested in the maintenance of the main removal surface of cores to maximize production of desired blade products. It appears that most Levantine communities of the 7th M.b.c. shared in these ends and that even the smaller sub-components of mobile communities in the arid zone had knappers with the necessary skill to execute those ends. A key question must be why those ends or those investments were no longer apposite.

As indicated, there are no contrasts in the employment of reduction strategies between the sedentary communities in the moister areas and the mobile groups exploiting the arid zone. The degree of use of naviform strategies is quite variable in the moister zone in the southern Levant, in the arid zone there and in the north Levant. In the north Levant its use was very frequent, compared to the south, at some sites where the Douara method was practised and at others such as Qdeir where it was not. This particular naviform strategy is absent from the south. Details suggest that the particular character of naviform production was replicated all over the south regardless of steppe/desert or moister setting. In particular, a strategy designed to exploit the edge of tabular raw material is well attested from Beidha and Basta, that is sedentary communities in the south of the southern Levant; but these tabular edge strategies are also attested from several different parts of the Azraq basin, including the *harra*, in the north of the southern Levant. One specific strategy/technique is restricted to the *harra*, but it is not universal: that is the possible use of splintered pieces for debitage production. This last strategy persists from Late PPNB into the late 6th M.b.c (sections 7.3.1, 7.3.3, and 7.3.4). One trait of naviform production suggests some significant variation in manufacture in the south as well. A high proportion of naviforms and their preforms are large on north Levantine sites (section 7.4). Relatively large naviforms and their preforms are only found amongst some sedentary communities in moister zone settings in the south Levant, namely Jericho and Beidha (sections 7.1.1.2 and 7.1.3.1). Many sites in the Azraq basin, including the *harra* (Qa'a Mejalla is the possible exception) have a relatively high number of smaller naviforms. These rarely exceed 100 mm. in length. Relatively small preforms exist on these sites as well. This is a pattern that persists through time in Jilat, from 8th M.b.c. to 6th M.b.c., and suggests some continuity in the execution of technological traditions there (section 6.5.2). In Jilat, although not necessarily Azraq or Dhuweila, the size of naviforms/preforms cannot be related to limitations in raw material availability or size. Intriguingly, the large blades from the Late PPNB at Azraq

31 seem most likely to have been produced from large naviforms off-site (sections 6.9 and 8.12.8). The only other arid zone site for which a significant amount of information was available, Nahal Divshon in the Negev, has relatively small naviforms (section 7.3.5).

Localized traditions seem to be reflected in different techniques rather than by clearly patterned variations in reduction strategy. Such variation in reduction strategy has been observed only at the broadest regional level, perhaps with the exception of splintered pieces. If splintered pieces represent bipolar on anvil production then they represent variation in technique as much as strategy. From 8th M.b.c. to early 6th M.b.c. all indicators of technique remain very similar in Jilat (section 6.8.2, table 6.12). In the early 6th M.b.c. assemblages there are indications of change, most notably at J25. Coeval with, at least, the latter part of the Jilat sequence there is a quite different pattern of technique indicators at Azraq 31. Here, technique(s) resulted in much more preparation of the platform edge on the main removal surface, much less facetting of the platform itself, a much higher proportion of very small platforms, and much more frequent indication of softer hammer use (section 6.8.4). Part of this phenomenon is an indication that some production occurred off-site. Dhuweila shares many features evident at Azraq 31, in notable contrast to Jilat (section 7.3.1).

An important question must be whether these technique traditions result from the presence of different groups exploiting the locales concerned, each with their own traditions, or whether these differences could represent the adaptation of technique to particular raw material requirements in different settings. In the case of Azraq 31 and Dhuweila, where raw material may have been brought in from some distance, such requirements might have included a need to maximize production of suitable debitage per raw material block, achieved by the greater use of softer hammer and main removal surface preparation techniques. Such contrasting patterns of technique usage are more widespread than merely within the Azraq basin, however. At Jericho, Ain Ghazal and Basta, even allowing for different identification criteria, punctiform/filiform platforms are far more important than in Jilat and even Azraq. Preparation of the platform edge on the main removal surface occurs in higher proportions and is more frequently effected with grinding. Where data is available (and as we might expect) softer hammer production was probably very important in these assemblages, not necessarily the case in Jilat. Clearly, at Azraq 31 and Dhuweila techniques were more akin to those in the aforementioned sedentary communities, but not the same. Intriguingly, the only other site with technique indicators at all similar to those in the Jilat assemblages was Nahal Divshon, with a significant proportion of facetted striking platforms and low proportions of soft hammer indicators (section 7.3.5). This is intriguing because it is the only arid zone site outwith the Azraq basin for which we have data. It begs the question as to whether similar technique patterns are more common in the arid zone as a whole than the moister areas. It seems unlikely that such coherent patterns of variation in technique would relate only to different raw material settings. Why then would the sedentary communities, in varied raw material settings, share a broad pattern of technique indicators, so clearly contrasting with those in coeval arid zone communities? If limitations of access to raw material were key, why should it be that softer hammer and platform preparation indicators were so much more important on the large permanent village sites of the moister zones than at Dhuweila or Azraq where limited access to raw material was also the case? Technique indicators vary quite independently of the frequency of employment of naviform strategies, so this is clearly not a factor. Given these circumstances it seems likely, whilst adaptation to different raw material settings may provide some explanation of localized and contrasting traditions of technique usage, that the behaviour of separate communities is also thus reflected.

In the moister areas the degree of continuity, on sites like Ain Ghazal (Rollefson *et al* 1989) and Basta, over lengthy time spans, is clear. The evidence of the production technology in Jilat and at Azraq 31 shows that distinct mobile communities, with enduring traditions, continued to use the same locales over lengthy periods. These questions of continuity, change and localized behaviour, raised by the evidence of chipped stone production technology, must clearly be reviewed in the light of other indicators of behaviour.