CHAPTER III: 'The Desktop Study'

The chapter begins with a very brief introduction of various methods, applied in experimental research. With this a description of the particular experimental method that is used by the researcher in the present work is also portrayed here. Models of experimentations as well as techniques of data collection, comparison and also mode of writing of present thesis are also explained here. The reasons for the selection of the various research methods are also explained in this chapter.

Desigining the Experiment

The researcher first fixed up the aims of research. A blueprint of the entire work was made. First of all present researcher concentrated on preparing an experimental design, which will be suitable for the knapping experimentation. After going through some literature on experimental designing and on experimental knapping, it became apparent that designs, applied in experimental archaeological research, especially in knapping experimentation are mainly based on "Quasi-Experimental Models" (Campbell and Stanley, 1963; cited in Shadish, Cook and Stanley, 2002:13). The author also found that the type of knapping experimentation which he was going to make fits within one of the models of Quasi Experimentation. Explanation for the reasons or conditions for the selection of quasi experimental model in present context is given in the later part of this disquisition.

In the field of natural science modern experiments can be divided into four different subtypes, they are- Randomized Experiment or True Experiment, Quasi Experiment, Natural Experiment and Non Experimental or Observational Study. Randomized Experiments or True Experiments are those experiments in which units are assigned to receive the treatment or an alternative condition by a random process. It is a type of experimental study in which an independent variable is deliberately manipulated and a dependent variable is assessed. Randomized experiments are highly prized in the field of natural science, because in randomized experiment the size of treatment effect has desirable statistical property, and from its result an estimation of probability can be made that the true effect of probability falls within a defined confidence interval (Shadish, Cook and Stanley, 2002:13-14).

Quasi experiment can be defined as an experiment in which experimental units are not assigned to the conditions randomly. The term 'Quasi-Experiment' was popularized by Campbell and Stanley (1963), but before them it was known to the researchers as 'Compromise Design' (Campbell, 1957; cited in Shadish, Cook and Stanley, 2002:13), or 'Observational Studies' (Cochran, 1965; cited in Shadish, Cook and Stanley, 2002:13). Like all other experiments quasi experiments have a common purpose, that is to test descriptive causal hypotheses about causes that could be manipulated, and to support a counterfactual inference about what would have happened in the absence of treatment. Quasi experiments have many structural similarities with other experimentations, such as, frequent presence of control groups and pretest measures. Unlike other experiments quasi experiments presents some special attributes, such as, lack of random assignment, selection of assignment by means of 'self selection' or 'administrative selection' and presence of alternative explanations for the observed effect (Shadish, Cook and Stanley, 2002:13-14).

The term natural experiment indicates a naturally occurring contrast between a treatment and a comparison condition (Zeisel, 1973; Fagan, 1990; Meyer, 1995; cited in Shadish, Cook and Stanley, 2002:17). In case of this experiment the treatments are not potential for manipulation. For example, if someone wants to examine the effect of Bird Flu disease on the monitory value of the chicken and other poultry related products he has to compare value of poultry products before and after the advent of Bird Flu disease. Here, the Bird Flu works as the naturally occurring contrast in the experimentation. Comparison of the value of poultry products before and after the advent of Bird Flu in the Bird Flu affected region with that of a Bird Flu unaffected region will help to examine the effect of this disease on the value of poultry products. Natural experiments are usually used by the economists in their studies. In case of non experimental designs presumed cause and effect are identified and measured. However, in this type of study structural features of experiment like randomization, experimental design, pretest and control groups are not followed (Shadish, Cook and Stanley, 2002:18).

As mentioned earlier, out of these four types of experimentations, quasi experimental model for the present lithic experimentation is selected. More precisely speaking 'Before and After with Control Design' (Bechhofer and Paterson, 2000:24; Kothari, 2006:41) is selected for the present experimentation. In this design the treatment groups and the control groups both are measured before and after the experiment. That is for each group there is both a pre-test and a post-test. In present context, the control groups of the experiment are the archaeological materials or artifacts recovered from various sites. These recovered artifacts were studied (pre-tested) by various archaeologists and they proposed a hypothesis regarding the nature and shape of the raw materials and the probable manufacturing process (or treatment) of those artifacts. The treatment group/ test group included same type of raw materials upon which the archaeological materials were made. Similar type of treatments (as hypothetically proposed by the archaeologists) was given on the raw materials to see whether it would be possible to produce same phenomena as those of prehistoric artifacts collected from the field. Finally, it can be said that by this entire experimental procedure the hypothesis proposed by the previous workers or archaeologists was tested.

It can be said that in present experimentation replicas of some ancient artifacts were made, and replication of a particular ancient behavior (in present context ancient tool making behavior) was done. For this reason it can be classified as 'replicative' experimentation. In fact most of the scholars when thinking of experimental archaeology, words like 'reconstruction', 'reproduction' and 'replication' come up in their mind because the people working in this field are involving themselves in recreating activities, artifacts, structures and processes that happened in the past (Outram, 2008:1). In reality the experiments conducted in experimental archaeology are not always following all the three principles proposed by R.A.Fisher, that is, Principle of Randomization, Principle of replication and Principle of local control (Biswas, 2008:220; Kothari, 2006:39). One of the most prominent examples of this incident is present experimentation.

In present experimentation quasi experimental procedures are used because the sites that were selected for this experimentation were not randomly done and the type of the tool, which were replicated; nature and shape of raw materials; were all purposefully selected. Because of the lack of the randomization in the experimentation, the design was derived from quasi experimental procedures, where such selection is well accepted (Shadish, Cook and Stanley, 2002:14). Another important reason behind the use of quasi experimental model in present context is also related with another feature of experimental archaeology. This feature is that, unlike true random experiments archaeological experiments can produce alternate hypothetical solutions to a single problem (Coles, 1979). Quasi experiments not only have the same feature but also it helps researchers to deal with the multiple alternative explanations and to find out which explanation will be plausible to a particular context (Shadish, Cook and Stanley, 2002:14-17).

Present experimentation had three different goals, and to achieve these three goals three different research designs are used. The quasi experimental model was used to achieve the first goal of this experimentation (Fig-3.1, p-135). The second goal of this experimentation was to find out variability of the debitage according to raw material type, technique of manufacture, and according to reduction stages, which are identified in this experimentation. A triple series comparison is developed by the researcher to find out debitage variability according to raw material and reduction stages. The triple series comparison was used because the debitage of three different raw materials (Fig-3.2, p-136) and three different reduction stages were compared in this type of test (Fig-3.3, p-137). To compare debitage according to the technique of manufacture a double series comparison was done because two different techniques (Hard Hammer technique and Soft hammer technique) were used in this experimentation (Fig-3.4, p-138).

In order to fully understand various reduction strategies, that were to be applied on various raw materials in order to turn them into hand axes and to find out nature of debitage produced in the knapping experiments, there arose a need for careful and explicit structuring of the experimentation, so that the variables could be controlled. This had significant effect on results of experimentation. To control confounding variables which could produce systematic errors in the experimentation, attempt was made to control everything constant except raw material types. The constant variables in the present experiments included the knapper, so that stylistic variation and variation in knapping skill of various people could be controlled; the knapping tools, that is the percussor and fabricator; method of force application, i.e. knapping technique; only hard hammer and soft hammer technique of knapping were used by the researcher; reduction goals and results of reduction. It may be mentioned that Acheulian hand axes were produced in this experimentation.

The third objective of present work was to understand knapper's perception or the thoughts and conditions of knappers mind at the time of manufacturing stone tools. In present experimentation 'the researcher' acted as knapper, for that reason in the present context knapper's perception actually depicts the researcher's own experience at the time of knapping. Study of the author's own perception is heavily informed by the reflection of his personal experience of "participating in the activity of knapping", which falls within the category of 'Reflexivity' or 'Reflexive Ethnography' in social science.

In the broadest sense the term reflexivity means "a turning back on oneself" or "a process of self reference" it refers to the ways in which the products of research are affected by the personnel and the process of doing research (Aull Davies, 1999:4). In reflexive ethnographies, the researcher's personal experience becomes important primarily in how it illuminates the culture under study (Ellis and Bochner, 2000:740). Furthermore, the relationships between ethnographer and the informant in the field are expressed through social interaction in which the ethnographer participates (Aull Davies, 1999:5). Throughout the present study the researcher's active participation in the knapping activity and interaction between him (the knapper) with various raw materials is reflected through the thought process and condition of his mind at the time of knapping. To be more precise, this interaction is reflected through the difficulties that the researcher faced at the time of knapping of diversely shaped raw materials and various strategies that he developed to overcome these difficulties, and this entire process of interactive experience falls within knapper's perception (Nami, 2010:122).

In present context recording of the researcher's own participation in knapping was done by the use of autobiographical texts (Aull Davies, 1999), which includes his laboratory diaries and the short notes that were taken after the detachment of each flake at the time of knapping. Through these autobiographical texts, the intention of giving each and every blow at the time of entire knapping process, results of each blow and the nature of resulting debitage and nature of flake scars were recorded and with these his own planning for knapping raw materials with diverse shapes were understood. Finally, by the study and understanding of these autobiographical texts and by the active participation in the knapping activity the researcher classified diverse knapping strategies that were applied in diversely shaped raw materials and it gives a glimpse of knapper's perception at the time of stone knapping.

Selection of Study Area and Raw Materials

For understanding reduction sequence of the entire manufacturing process of various lower Paleolithic handaxes, found in eastern part of India. Three different lower Paleolithic sites were selected. These were considered as three cases in the present experimentation. The lower Paleolithic sites were selected from three major industrial locales[2] of eastern India. The selected lower Paleolithic sites were Pallahara of Orissa, Dahigora of the Singhbhum region of Jharkhand and Belpahari of West Bengal. Lower paleolithic culture of this part of India is dated to middle part of Pleistocene, about 0.3 mya (Badam and Rajaguru, 1994). The main reason behind the selection of these sites was that, geological features and cultural assemblages of all these sites were already well documented and studied by a number of scholars like, Mohapatra (1962), Ghosh (1970), Mohanty (1993), Ray (1994,1995), Ray *et al* (1997), Basak (1997a, 1997b; Basak *et al*, 1998). A good amount of data on lithic assemblages of these sites already existed and part of present work was formulated on this existing data. Another significant reason behind the selection of these sites is their location in particular lithic industrial zones (i.e. locale 1, 2 and 3). These three lithic industrial locales are highly significant because of the presence of higher density of sites, variability in the use of lithic raw materials and

[2] According to Ghosh *et al* (1991) lithic Industrial complex of eastern India can be divided in six different locales. Locale 1 consists of part of Jharkhand and Singhbhum district; Locale 2 consists of northern part of Orissa including Mayurbhanj and Keonjhar district: Locale 3 consists of West Bengal, Locale 4 includes Hazaribagh, Ranchi and Dhanbad region of Bihar and Jharkhand; Locale 5 consists of Palamau district and Son river system and Locale 6 includes only a single site- Bhimbandh of Bihar.

also due to the presence of earliest variety of lower Paleolithic tools in eastern India, which had been identified on the basis of typo-technological attributes (Ghosh *et al*, 1991:40).

Throughout this experimental knapping the researcher replicated predominant types of hand axes found in the selected sites, and knapping was based on the hypothetical Acheulian technological tradition on Pebble Core proposed by Ghosh (1970) and Ray (2003). In this context it must be mentioned that Lower Paleolithic tools of Indian subcontinent are made either on cores or on large flakes. In most of the regions of India bifaces made on large flake are found in abundance (Corvinus, 1968; Jacobson, 1975; Paddayya, 1977; Mohapatra, 1981). On the basis of this evidence it is assumed that some large flake technological tradition of African Acheulian such as, Vaal River II technology or Kombewa technology were used by the prehistoric people of India (Mohapatra, 1981; Mishra *et al*, 2007). However, studies on the Acheulian technological traditions of eastern part of India have shown that along with the tools of large flake of Acheulian technological tradition (Mishra *et al*, 2009) some bifacial tools are found, which are mostly made on cores or pebble cores (Ray, 2003). Ghosh (1970) indicated that Acheulian tools, made on core, belong to the earlier stages of Acheulian and termed them as Chopper Biface System (Ghosh, 1966) or Pebble Core Acheulian Technological Tradition (Ghosh, 1970; Ray, 2003).

The author has selected Acheulian technological tradition on pebble core due to three different reasons. The first reason is related to the typological features of the hand axes recovered from the selected sites. Studies of the hand axes recovered from the selected sites has shown that pebble cortex is found over them and large bulb of percussion or bulbar surface of flake detachment on them are absent (Ghosh *et al*, 1991:40; Ghosh and Das, 1966:88; Ray, 1999:366). This fact indicates that they were made on pebbles collected from nearby rivers or rivulets and were not made on large flakes detached from large cores. Absence of Mammoth cores and Kombewa like flakes in the cultural assemblages also supports the above mentioned fact. As mentioned before in this study the researcher tried to replicate predominant hand axes found in the selected sites, he has used same form of raw material (pebble core) upon which original tools were made.

The second reason is that the presence of hand axes, made on pebble core is a unique feature of East Indian Acheulian technological tradition that is why the researcher selected to replicate tools of this tradition. The third reason is for judging the validity of this technological tradition. As mentioned, claims of the previous scholars regarding the existence of this technological tradition in eastern India were based mainly on the study of the tools recovered from the field. However, till the beginning of the present work no one had tried to prove the existence of this technological tradition in eastern India on the basis of knapping experimentation. Application of Acheulian technology on pebble core raw materials in present knapping experimentation created an opportunity to validate or judge its existence in the Acheulian techno-complex of eastern India.

Coles (1973) have postulated that the materials used in experiments should be those considered to have been locally available to the ancient society. Following this procedural rule of experimental archaeology, scholars (Jones, 1979; Toth, 1985, 1991; Ahler, 1989) have found that one successful way to structure replicative experimental analysis is by performing experimentation with locally available raw materials, which had been used by prehistoric men. For this reason decision was made to use Quartz, Quartzite and Metadolerite in this experimentation. All these raw materials are found in abundance in eastern India and these were also used by the lower Paleolithic knappers of this region to make their tools[3].

Another reason behind the selection of these three raw materials was that, all these raw materials were available in the three sites namely, Pallahara, Dahigora and Belpahari, which are selected as three cases for understanding reduction sequence of the entire manufacturing process of various lower Paleolithic handaxes, found in eastern part of India. Beside this, hand axes recovered from these three sites are made on three types of

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[3] Studies on the Stone Age cultures of Eastern India have shown that quartz and quartzite were mostly used by lower Paleolithic people to make their implements (Mohapatra, 1962; Ghosh, 1966, 1970). However, Ghosh (1970) in his work on the Paleolithic cultures of Singhbhum mentioned that except quartzite and quartz some other silicious rocks were also used by lower Paleolithic people to make their tools but he did not mention the exact type of this 'other silicious rock'. Finally after studying the collection of implements made by Ghosh from the Singhbhum region present author found that except quartz and quartzite a few implements were made on some igneous rocks like altered Basalt and Metadolerite.

raw materials selected. For this reason also the three raw materials for present study are selected.

Selection of Techniques for Experimental Study and Analysis

Technique of knapping and method of data collection, selected in the present study were mainly based on the objective of the present work. The main intention behind the selection of various techniques was to get proper and errorless results which could help this work to fulfill its aims. Regarding the selection of the technique of knapping and collection of debitage two different principles are followed. Since the aim of knapping each raw material was to prepare replica of Acheulian hand axes of eastern India, the present knapper/ the researcher decided to stop only when he would feel that the manufacture of the replica had become complete. To understand reduction sequences of knapping as well as knapper's perception he decided to take notes after each successful blow of knapping. Besides this the researcher decided to record entire reduction sequence by writing laboratory diary, taking photograph and drawing diagrams after each successful strike and after each reduction stage. Regarding the collection of debitage, it was decided to collect them after each successful blow of the percussor, as some knappers (Ingbar *et al,* 1989; Magne, 1989; Mauldin and Amick, 1989; Odell, 1989) have done in the past. This usually helps researcher to easily classify resulting debitage according to the technique of manufacture and reduction stages. Besides this, collection and sorting of individual debitage helps in the individual flaking attribute analysis of debitage.

Selection of the technique of debitage analysis was also based on the aim of the study of the debitage and also on the nature of the comparison that the researcher intended to make among various debitage. The major aim of the analysis of debitage was to get an idea on the variation of debitage according to the raw material. However, along with this major aim the present researcher was also interested to understand degree and nature of debitage variability according to the reduction stages and also according to the technique of manufacture. In order to accomplish these three aims, two different techniques of debitage analysis are selected. One is Mass Analysis of debitage, which is developed by Ahler (1989) and the other is Individual flaking attribute analysis of debitage (Andrefsky, 2005). Among various methods[4] of mass analysis of debitage, the reason behind the selection of Ahler's (1989) method of analysis is that it analyzes extremely large amount of debitage in a quick manner and it also helps to process all debitage regardless of shape and size (Andrefsky, 2005: 135). Another reason behind the selection of Ahler's method of analysis is that this method of analysis falls within the category of Screen Size Graded Debitage Analysis. Experimental studies of previous researchers have shown that Screen Size Graded Analysis helps to classify debitage of various biface reduction stages (Patterson 1979, 1982, 1990; Patterson and Sollberger 1978; cited in Andrefsky, 2005: 135-136). It could help comparing resulting debitage of various reduction stages of hand axe manufacture as well.

Individual flaking attribute analysis, selected for knapping, consisted of 10 different measurements of various fracture properties of flake debitage and also of the nature of the same. In this method data regarding the condition of flake (Mierendorf and Bobalik 1983; Odell 1989; Sullivan and Rozen 1985; Crabtree 1972; Lyons 1994), nature of striking platform (Magne and Pokotylo, 1981; Tomka, 1989), flaking angle (Cochrane, 2003), length and width of striking platform (Pokotylo, 1978; Magne and Pokotylo, 1981) , length, breadth and thickness of flake (Flenniken, 1981; Gero, 1989), amount of cortex (Andrefsky, 2005) and number of dorsal surface scars (Andrefsky, 2005) were counted and measured for each flake of the debitage assemblage. Among infinite number of individual flaking attributes the reason behind the selection of these 10 attributes was that all these attributes were most common and most easily measured or studied ones, which were used by various researchers to investigate various problems related to fracture property of debitage, identification of reduction stages and also regarding the identification of the technique of manufacture from various debitage (Andrefsky, 2005).

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[4] Mass analysis of debitage can be divided into three different types, Linear Size Debitage Analysis, Screen Size Graded Debitage Analysis and Weight Increment Analysis of Debitage. Ahler's (1989) method of Mass Analysis falls within the category of Screen Size Graded Debitage Analysis (Andrefsky, 2005).

An Understanding of the Techniques of Debitage Analysis

As mentioned already that Ahler's (1989) mass analysis method of debitage analysis and various individual flaking criteria for debitage analysis are selected for the present study. The reasons behind the selection of those criteria are also explained above. A description of the above mentioned methods of debitage analysis is given below.

Ahler's (1989) method of Mass Analysis

Mass analysis or aggregate analysis of debitage is an alternate approach of the individual flaking attribute analysis of debitage. Among various archaeologists, this method of debitage analysis developed by Ahler (1989) is most famous. In this method all debitage assemblage is sieved through a progressively smaller screens and the number of pieces, total weight, and the number of cortex covered pieces are recorded for each screen size. This method of analysis is based on two assumptions: 1) stone working is a reductive process, so as the reduction process proceeds, the individual pieces produced will be smaller in size; 2) In case of cortex covered raw material the resulting debitage will have less cortex cover at the later part of the reduction sequences. Following Ahler (1989, cited in Kooyman, 2000:62) the standard sieve size used in present mass analysis include one inch (G1), ½ inch (G2), ¼ inch (G3) and 1/8 inch (G4). After sieving data regarding variables like weight of the debitage in each screen, total number of flakes in each screen, number of cortical flakes and number of biface reduction flakes were gathered and then percentage value of the gathered data were compared to gather various technological information.

Individual Flaking Attribute Analysis

Individual flaking attribute analysis is the most commonly employed approach of debitage analysis. In this method various flaking or fracture attributes of each and every flake of debitage assemblage is studied and compared. From this entire data technological attributes and the stages of reduction etc are identified. Individual flaking attribute analysis was done on the debitages of 6 typical raw materials which were identified by geologists by Petrological analysis. Following individual flaking attributes were selected for the present experimentation.

Flake/Debitage Condition: Flake condition or debitage condition refers to the fact whether the debitage is broken or unbroken. In present context if it is observed that a debitage has its proximal and distal end intact and if type of striking and debitage termination is properly identified then it is considered as unbroken debitage, but if the above mentioned features of a debitage are not properly identified then it is considered as broken debitage.

Debitage Termination: The term refers to the type of termination of the flake debitage. It can be identified by the study of the distal end of an unbroken debitage. In present context four types of terminations are identified, they are feather termination, step termination, hinge termination and overshoot termination (Cotterell and Kamminga, 1987).

The term feather termination refers to the termination where the crack forming the flake that has been propagating parallel to a side face of the core turns slightly to meet it at a very acute angle (Cotterell and Kamminga, 1987:699). It can be further referred as smooth termination that gradually separates the flake from the objective piece (Andrefsky, 2005:87). Usually the dorsal and the ventral surface of a feather terminated flake meets with each other at an acute angle.

Step termination flakes or step terminated flakes referred to the type of flakes where the end or the distal end of the flake terminates at a right angle break. This usually means the flake was broken, and the original force and crack may have continued into the core, with or without completing the removal of the rest of the flake (Whittaker, 2009:17-18). Step terminations are caused by the crack arrest. The reason behind this may be insufficient energy applied to complete a fracture or it may be the presence of flaw in the raw material. Due to the second reason cores of highly flawed raw material like quartzite may frequently have step termination (Cotterell and Kamminga, 1987:700).

The distal end of a hinge terminated flake is usually blunt with a rounded cross section. Usually these forms of flakes are formed with the increase in the bending forces, which cause the force of impact to turn toward or away from the distal piece (Cotterell and Kamminga, 1987:701; Andrefsky, 2005:29).

The over shoot terminations are sometimes identified as *Outer passé* or plunging terminations (Cotterell and Kamminga, 1987:701) by several lithic analysts. In this type of terminations the crack and the applied force during knapping runs to the end of the core and then instead of existing on the core surface it bends downwards and removes part of the end of the core with it (Whittaker, 2009:19). As a result of this the resulting flake will have an extra extension of the lower surface of core with its terminal end.

Striking Platform Type: In present context the term striking platform type refers to the condition of striking platform of the detached flake i.e. whether they present cortex on them or they are flaked or manipulated by rubbing, flaking or abrading before the detachment of flakes. In present context striking platforms are categorized according to Andrefshy's (2005) classification of striking platform types. In this classification four different striking platforms are identified, they are cortical, flat, complex and abraded. A cortical striking platform presents cortex of the pebble or cobble on it. Presence of cortical surface indicated that the striking platform was not prepared or modified before the detachment of flake. Flat striking platforms are identified by the presence of flat surface of flake detachment on it. It indicates that the striking platform was modified before the detachment of flake. Usually flat striking platforms are presented when small flakes are detached at the time of making a biface. Striking platforms with multiple flake scars are identified as complex striking platform and striking platforms with complex scars and abrasion marks on them are classified as abraded striking platforms. Both type of striking platforms indicated preparation of striking platform before the detachment of flake and both of them are typical feature of biface reduction (Andrefsky, 2005).

Striking Platform Angle: The term striking platform angle refers to the angle formed by the striking platform and the ventral surface of the flake (Dibble and Whittaker, 1981; Shot, 1993; cited in Andrefsky, 2005:92). Sometimes this angle is referred as flake's initiation angle. Cotterell and Kamminga, (1987: 676-677) have given detail about the same.

Striking Platform Facet Count: It refers to the number of flake scars or facets visible on a faceted or prepared or modified striking platform (Andrefsky, 2005: 92-94).

Striking Platform Width and Thickness: Striking platform width and thickness are two different features of striking platform, but the reason behind defining them together is that both of them cannot be defined without mentioning or defining each other. The striking platform width is the distance of striking platform from lateral margin of one side to the lateral margin of another side. Striking platform thickness is defined by a line perpendicular to the striking platform width; it is the greatest distance of striking platform from dorsal to ventral surface following that line (Andrefsky, 2005:94).

Flake Length: Flake length is defined as the greatest straight line distance between the proximal ends to the distal end of the flake, perpendicular to the wide axis of the striking platform (Andrefsky, 2005: 99).

Flake Width: It refers to the greatest straight line distance perpendicular to the flake length line (Andrefsky, 2005:99).

Flake Thickness: It refers to the maximum thickness measured from the dorsal surface to the ventral surface of the flake perpendicular to the flake length line. (Andrefsky, 2005: 101).

Amount of Dorsal Cortex: A four rank ordinal scale (developed from the concepts of Andrefsky, 2005:106) is used for this measurement. Here four values are used for the scale. Value '3' is the highest in this scale and it is scored only when the entire dorsal surface (100%) of the flake is covered by the cortex. Value '2' is given when the dorsal surface of the flake present cortex cover less than 100% but more than or equal to 50%. Value '1' is given only when the dorsal surface of the flake present cortex covers less than 50% but more than 0%. Value '0' is scored when the dorsal surface of the flake do not have any cortex cover. Here the scale is given-

Amount of Cortex Cover on Flake	Score
100%	3
<100% - ≥50%	2
<50% - >0%	1
0%	0

Dorsal Scar Number: It refers to the number of flake scars found on the dorsal surface of a flake. Dorsal surface scar counts are extensively used by the archaeologists to determine stage of reduction and type of objective piece (Andrefsky, 2005:106).

Statistical Methods Applied in Present Work

Since one of the three aims of present work is to understand variability of debitage according to raw material type, reduction stages and method or technique of knapping, three different statistical tools are selected for this comparison, and attempt is made to find out whether any significant difference exist. Statistical tool that is used include t-statistics, one way ANOVA and χ^2 test of independence. The reason behind selection of these statistical methods is the nature of data that are compared in present experimentation and also is based on the type of comparisons made in this study. T- test or more precisely independent sample t- statistic is used to compare means of two independent samples of a given variable (Urdan, 2005:89). For example in present work variables like individual flaking attributes are compared with two independent samples or two independent groups like hard hammer percussion technique and soft hammer percussion technique. In the present experimentation, one way ANOVA is used to compare mean value of the variables, like individual flaking attributes, are compared against three independent samples or group. For instance to see whether the mean value of individual flaking attributes differ significantly according to raw material types one way ANOVA is used. The above mentioned statistical methods are used to compare parametric data, i.e. the type of scores on some measure like flake length, flake width, striking platform width etc which are assumed to be normally distributed. But some other type of data or information were collected in present work, which do not follow normal distribution, for example, debitage condition, debitage termination etc. To compare the above mentioned types of data non-parametric statistics like χ^2 test of independence is used.