One of the difficulties inherent in the study of the later stages of human evolution is the need to reconcile two different taxonomic systems, the biological systematics of hominin fossils and the archaeological systematics of stone tool assemblages. Nowhere is the situation more complex than the period usually referred to as the Middle Paleolithic. In evolutionary biology there is disagreement over what is meant by such seemingly simple terms as Neanderthals and modern humans. Archaeologically much of the debate revolves around the meaning of the term Levallois. The recent publication of three volumes dedicated to the study of the Levallois—two monographs and one collection of essays from an international conference—provides an opportunity to clarify the different approaches to archaeological systematics and how these approaches affect our understanding of the later stages of human evolution.

Archaeological systematics, as applied to the study of Paleolithic stone tools, can be divided into four overlapping approaches:

**Typological approach**

Following the typological approach, retouched stone tools are seen as finalities which can be characterized by shape and the location/characteristics of retouch (Bordes, 1961). On the basis of the quantitative representation of types of retouched tools, assemblages can be grouped to define cultural entities (Laville et al., 1980). This is a genealogical approach to archaeological systematics based on the assessment of the degree of morphological similarity between assemblages. A variant of the typological approach, advocated by Lewis Binford, interprets typological similarity not genealogically but rather in terms of shared function (Binford, 1973; Binford & Binford, 1966).
Grade approach
Following much the same methodology as typological systematics, assemblages are divided into evolutionary grades rather than culture groups (Clark, 1969). An example of a grade approach is found in the Russian prehistorian Lubin’s discussion of Levallois: “The appearance of [Levallois] technique was an act of international–historical meaning and was one of the greatest examples of successful technical progress during the Lower Paleolithic epoch, on the basis of which future technological process continued not only in the second half of the Lower Paleolithic, but in [the] Upper Paleolithic [as well]” (Lubin 1965 quoted by Ranov in Dibble & Bar-Yosef, 1995). Grade and typological systematics are often combined to form systems in which grades are broken down into cultural groups (Chazan, 1995).

Nominalist approach
Typological systematics is rejected as a meaningless classification largely imposed by the analyst. A quantitative approach to artefact morphology is advocated, to be interpreted within an adaptive framework which stresses such factors as raw material availability, tool function and rejuvenation, and environmental stress. Rather than looking exclusively at retouched tools the entire assemblage including tools, waste flakes, and cores is included in the analysis (Dibble & Rolland, 1992).

Technological approach
Typological analysis of finalities is deemed inadequate. The goal of analysis is to understand the method used in tool manufacture through a study of the entire assemblage. Classification is based on the method of manufacture rather than on the tool types found in the assemblage. The object of classification is not the artefacts but the behavior of the individuals who created these artefacts.

The impetus for the three volumes under review is the recent developments in the technological approach which have had a dramatic and controversial impact on archaeological systematics (Schlanger, 1994, 1996; Anon., 1979, 1990, 1991; Lemonnier, 1986, 1992; Berthelet & Chavaillon, 1992; Inizian et al., 1992). As is the case with cladistics, the adoption of a technological approach brings both clarity and an enormous number of both methodological and theoretical problems.

The remainder of this review is made up of three parts. The first section provides a brief overview of the concepts and terminology used in technological analysis. This overview will be followed by a discussion based on the monographs by Boëda and Van Peer of how technological analysis has been used to redefine the Levallois. Finally, based on the essays in the volume edited by Dibble & Bar Yosef (from now on referred to as the Levallois Conference) the views of those who employ non-technological systematics will be explored along with some of the theoretical and methodological challenges recognized by the technologists.

Basic concepts of the technological approach

The nature of technology
The view of technology employed by the technologists is based on three definitions relevant to the technical act: technique, method, and chaîne opératoire (Pelegrin, 1985, 1990, 1991, 1993; Geneste et al., 1990; Karlin et al., 1991; Lemonnier, 1992; Perlès, 1992). These terms are meant to be applicable to any human technical act.
At the most basic level all human technical acts involve the transfer of energy. One way of defining a technical act is that it is any act where the transfer of energy is used to cause some effect on the physical world. Dancing, which involves the transfer of energy, would not be counted as a technical act.\(^1\) A tool serves as intermediary between the body and the physical world for most of the technical acts studied by archaeologists. The term “technique” is used to refer to the nature of the transfer of energy. Lithic analysts differentiate between hard hammer and soft hammer techniques referring to the nature of the percussive instrument. A further distinction is between direct percussion technique (in which force is applied directly by a hammer) and indirect percussion technique (in which the force is directed through a punch held between the hammer and the material being worked). Allied with the technique used is the precise nature of the gestures involved in a technical act (Bril, 1991). This level of analysis is rarely accessible archaeologically but is central to much anthropology of technology.

A technical act involves more than the flow of energy. Tool use and manufacture requires a conceptual model held by the person carrying out the act. Technologists call this conceptual model the “method”.\(^2\) It should be noted that the exact nature of the mental representations which guide technological action is open to debate (i.e., to what extent is the craftsman conscious of the method he or she is using?). For chipped stone tool manufacture the method refers to a three-dimensional spatial model of the mass to be worked.

Flint knapping involves controlling the force produced when a piece of raw material is struck with a hammer such that a flake of a particular morphology is produced.\(^3\) The goal of the knapper might be to produce a flake tool, which will be removed by percussion from the block of raw material, or to produce a core tool by removing flakes from the block to shape a tool.\(^4\) Although the control of the process of knapping involves the skillful placement of blows, what is crucial is the configuration of the shape of the mass being struck. A skilled knapper has the ability to determine the geometrical construction of the mass being worked and thus control the morphology of the product.

As Van Peer (1992: p. 37) states in his monograph: “When a force is applied close to the surface of a body, the propagation of the force through the mass of the body will be along those points which are situated in the same plane”. Using this principle, it follows that the thickness of the surface that receives the blow (striking platform); the convexity of the surface off which the flake is being struck (flaking surface); and the angle at which the striking platform and flaking surface meet are crucial for controlling the morphology of the flake removed (Figure 1). What adds to the complexity of the methods involved in flint knapping is that there is great advantage to using a method that allows for the continuous exploitation of a block of raw material. As Mark Baumler writes in his article from the Levallois Conference: “Each core reduction sequence must operate with (1) a restricted, ever-decreasing amount of raw material, and (2) a directional or irreversible organization of possible outcomes, each of which is influenced by what has occurred previously” (Levallois Conference p. 12). Thus, the knapper must not only put into place the criteria necessary for producing a particular flake but must consider how this removal will affect the overall morphology of the block and its future productivity.

\(^1\) However, see Marcel Mauss’ discussion of techniques du corps (Mauss, 1950).

\(^2\) I am including under method a number of terms which are used differently by different researchers. These terms include schema and concept as well as method.


\(^4\) One can also have industries where the knapper is both working to produce flakes and shape a core tool.
1. Thickness of the striking platform

2. Convexity of the flaking surface

3. The angle at which the two surfaces meet (this must be less than or equal to 90 degrees)

Figure 1. Diagram showing the effect of platform thickness, angle between platform and flaking surface, and the convexity of the flaking surface on flake size. These diagrams represent a cross section of the core. They are a simplification of the process of knapping which involves the manipulation of a three-dimensional spatial model. It should be kept in mind that these two-dimensional diagrams do not capture the complete complexity of the three-dimensional structures involved in flint knapping.
In summary, the methods used in flint knapping involve the configuration of a core to allow the regular production of flakes. It follows from the principles presented here that the methods for flint knapping are finite in number.

The stable mental representation of a method can be contrasted with the sequential nature of the technical act. Technical acts rarely involve a single gesture, or even a single technique. André Leroi-Gourhan coined the term _chaîne opératoire_ to express the unfolding of a technical act³ (Leroi-Gourhan, 1993; Schlanger, 1994; Cresswell, 1982; Sellet, 1993).

_Learning theory_

Human technical behavior is learned behavior. This generalization is supported by the technological uniformity in archaeological contexts along with ethnographic observations of technical behavior (Young & Bonnichsen, 1984; Chevallier, 1991; Mithen, 1994). The exact mechanisms involved in the transfer of technical knowledge is less clear. The technological approach is based on a distinction between skill (_savoir faire_) and knowledge (_connaissance_) (Pelegrin, 1993; Roux et al., 1995 present a somewhat different definition of skill). Skill refers to the ability to carry out precise patterns of movement. Included are the precise control of specific gestures and the degree of force employed, as well as the ability to regulate gestures on the basis of visual cues, eye–hand coordination. Skill is largely unconscious and must be learned through actual experience, as well as observation. Knowledge refers to the mental representations involved in a technical act, as well as specific pieces of information. For flint knapping such information includes the properties and location of various raw materials and the properties of various types of hammers. While the craftsman might not be fully conscious of the knowledge employed in a technical act it is assumed that this knowledge can at least potentially be verbalized. Although observation might be adequate for the acquisition of certain types of knowledge other types of knowledge might require active tutelage or even verbal instruction.

Sports metaphores are often used to illustrate the dichotomy between skill and knowledge. If one takes billiards, skill refers to the abilities involved in using a cue to accurately hit the ball; knowledge refers to an understanding of the rules of the game, as well as an appreciation of the consequences of various shots. Billiards is a particularly apt metaphor for lithic analysis as it requires abstract spatial thinking and is irreversible.

**The Levallois method and Middle Paleolithic variability**

The term Levallois has been in use with a variety of meanings since the nineteenth century. In its earliest incarnation Levallois referred to artefacts which represent a technological stage between handaxes and blade tools. Gabriel de Mortillet defined Levallois flakes as “very long and wide flakes, ovoid in shape, nice pieces with clear ridges which are the largest of their epoch” (De Mortillet, 1883: p. 225). In 1909, V. Commont produced a more detailed definition of Levallois in terms of careful bifacial preparation of the core along with a faceted striking platform (Commont, 1909).

François Bordes developed three criteria for the recognition of Levallois industries. The clearest of these, following Commont, was the identification of bifacial “tortoise shell cores” as Levallois cores. Bordes also defined Levallois as a method for producing flakes in which the

³_Chaîne opératoire_ can be translated as operational sequence. This term lacks the evocativeness of the French term which has been widely used by both ethnographers and archaeologists. Part of the strength of _chaîne opératoire_ is due to its relationship with the term enchainment (roughly translated as sequencing).
form of the flake is predetermined by shaping of the core. There are two major problems with this criterion. The first is that predetermined is characteristic of many methods of flake production. The second problem is the implication that the analyst is able to determine the intentions of the knapper. It is not clear that such a determination is possible based on the analysis of archaeological material.

In developing his typology for the Lower and Middle Paleolithic, Bordes was careful to provide archaeologists with clear diagnostic tools, specific things to look for in order to define an assemblage. As Isaac Gilead writes in the Levallois Conference volume: “For most users, Bordes’ method offered a simple and straightforward way of handling the sometimes inexhaustible quantity of artefacts in their assemblages and of easily tracing inherent variability” (Dibble & Bar-Yosef, 1995: p. 79). In his third criterion for defining Levallois, Bordes did not achieve such clarity. Bordes left the definition of a Levallois flake as a flake made using Levallois knapping, rejecting Commont’s insistence on a faceted platform. The ability to recognize Levallois flakes was left to the experience of the analyst. Controlled tests have shown significant disagreement among lithic analysts as to what pieces are Levallois flakes (Perpère, 1986).

Among the most convincing arguments made by the technologists for the inadequacy of Bordes’ definition of the Levallois is that a piece with a Levallois morphology can be made with a multitude of methods (Marks and Monigal and Boëda in the Levallois Conference). A morphological Levallois flake is not necessarily made on a Levallois core. Determining a cut-off point on the Levallois index (the percentage of Levallois flakes in an assemblage), beyond which an assemblage is Levallois, is not a solution.

The crucial step for the technological study of the Levallois was to produce a precise technological definition of the Levallois. In a series of papers, a group of technologists, including Eric Boëda, Jacques Pelegrin, Jean-Michel Geneste and Lilliane Meignen, have redefined the Levallois as a method in the sense described above (Boëda & Pelegrin, 1980; Boëda, 1991; Geneste et al., 1990). Five criteria have been defined for the Levallois method (Figure 2):

1. The volume of the piece to be worked is conceived as two surfaces that meet at a plane of intersection.
2. The two surfaces are hierarchically related, one being the platform face (usually the more convex of the two) and the other being the production face.
3. The production face is organized such that the morphology of products is predetermined. This predetermination is based on the management of lateral and distal convexities.
4. The fracture plane for the removal of predetermined flakes is subparallel to the plane of intersection between the two faces.
5. The striking platform is organized so as to allow the removal of the predetermined flakes from the production surface. This requires that the intersection of the striking platform surface and the flaking surface must be perpendicular to the flaking axis of the predetermined flakes. At the level of technique it is stated that the Levallois method is used only with a direct percussion hard hammer technique.

Significant flexibility within the Levallois becomes evident when the technological definition of Levallois is adopted. A Levallois core can go through a number of stages of repreparation and re-exploitation (Figure 3). Between each phase of exploitation both the production face and the striking platform face must be reconfigured. Flakes are classified by the role they play in this sequence as either predetermining (from the configuration phase also called preparation flakes) or predetermined (from the exploitation phase). If the core is reconfigured in the same
way between each phase of exploitation the morphology of the flakes will not change (size will diminish through the sequence). At this first level, Levallois industries can vary in terms of the number of phases of reconfiguration and exploitation.

The most important variability within the Levallois methods is in the configuration of the striking platform face and the production face, which determines the morphology of the blanks removed from the production face. The most basic distinction is between linear and recurrent methods. In a linear method, the production face and the striking platform face are configured so as to allow the removal of a single very large flake, which will carry off most of the production face [Figure 4(a)]. The core then must be reconfigured before another large flake can be removed. The products of a linear Levallois method tend to be large oval flakes, although cases where triangular pieces are made are also known [see examples in Van Peer (1992) chapter 4].
In a recurrent method, the production face and the striking platform face are configured such that a series of removals can be taken off before the core needs to be reconfigured [Figure 4(b)]. There are a multitude of patterns which the recurrent method can take—i.e., unidirectional parallel where a series of parallel removals come off the same edge; unidirectional convergent where a series of convergent removals come off the same edge; bidirectional where removals come off of opposing edges; and centripedal where removals come from around the periphery of the core. The crucial point, which has been demonstrated repeatedly through experimentation, is that the configuration of the two faces must suit the specific recurrent method employed.

The redefinition of the Levallois, as a method embracing a range of specific applications, has led to a clarification of the intentionality involved in Levallois knapping. We can now decouple two separate concepts: determination and intentionality. Technological analysis has confirmed Bordes’ observation that in the Levallois method the morphology of the flake is determined by the configuration of the core. Predetermination means only that the core has been shaped in a specific way to control the propagation of the force applied for the removal of predetermined

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**Figure 3.** Schematic reduction sequence of a core from the site of Makhadma 6, Egypt showing three stages of Levallois exploitation. (a) Transversal section. Levallois end products are in black; dashed lines show core selection at various reduction stages. (b) Longitudinal section. Levallois end products are in black; dashed lines show core section at various reduction stages and vertical lines show stages of platform preparation. This schema is based on the physical refitting of a core (after Van Peer, 1992: Figure 6).
flakes [Boëda (1994) pp. 12–15]. The issue of intentionality refers to the state of expectation in the knapper, and raises the specter of attributing our perspectives to prehistoric people. We do not know to what extent the expectation of the knapper involved the production of by-products, as well as the predetermined products. What we can say is that the entire project of knapping was carried out with a specific plan of action and knowledge of the end products of this plan.

A consequence of the redefinition of the Levallois method has been the recognition of non-Levallois Middle Paleolithic methods of debitage production. The most important of these are the discoid method, the trifacial method, and the newly identified blade production method (Boëda, 1989, 1991, 1993; Revillion & Tufféreau, 1994). In each of these methods, the

![](image)

Figure 4. (a) Linear Levallois core; (b) Recurrent Levallois core (centripedal) (from Van Peer, 1992: Figure 21:3 and Texier & Francisco-Ortega in Dibble & Bar Yosef, 1995: Figure 15:6).
form of the flake is determined by the configuration of the core. The spatial configuration of the core differs for each method (Figure 5).

**Critiques of the technological approach**

It is clear from the papers collected by Dibble & Bar-Yosef that the technological definition of Levallois has elicited reactions ranging from euphoria to indifference or hostility. There is a strong sociological component to this reaction. The technological approach has been developed by a group of collaborating researchers in the French Centre National de la Recherche Scientifique whose publications are not widely available. As a result the archaeological community has been presented with a system of analysis, which is already in advanced stages of elaboration. When presented with such an edifice, the initial reaction tends to be either acceptance or rejection. One of the achievements of the volume edited by Dibble & Bar-Yosef (1995) is to remove the technological approach from its insularity and to begin widening the debate. The issues raised at the Levallois Conference focus around three crucial issues: (1) The methodology of technological analysis; (2) The discreteness of methods of knapping; and (3) The genealogical implications of technological systematics.6

The methodology of technological analysis

The work of Eric Boëda represents a pioneering effort. Boëda has erected a system of terminology and concepts to support a technological approach to artefact analysis. In this process he has relied on flashes of intuition, largely culled from the process of comparing archaeological assemblages with the material generated in the course of experimental knapping. Boëda has shown little interest in developing a methodology to test his observations. Rather, he has focused on methods of documentation and illustration. Boëda’s analyses of archaeological material involve preparing diacritical drawings of flakes and cores (Figure 6). Diacritical drawings differ from traditional archaeological illustrations in that they are meant to depict the sequence of operations involved in manufacture rather than to provide a simulacrum of the artefact. In Boëda’s drawings the focus is on the sequence of scars on the dorsal face of the flake which provide evidence for the sequence of preceding flake removals or the sequence of scars on a core, indicating the sequence of removals in the final stages of exploitation. On the basis of the combined evidence from cores and flakes a picture of the entire knapping sequence is built. This method has been widely adopted by French prehistorians and is exemplified in the articles by Bietti and Grimaldi, Delagnes, Texier and Francisco-Ortega, Marks and Monigal, and Meignen.

Van Peer is sharply critical of this approach to analyzing archaeological assemblages. Van Peer advocates “physical reconstruction of reduction sequences” or core refitting. In such a process the flakes are reattached to the core in the reverse order of their removal during knapping. Core refitting requires that knapping of complete sequences took place on site and that pieces were not taken off the site. In his monograph, Van Peer (1992) presents the results of analyses of refit cores from Nubia. On the basis of refit cores Van Peer is able to reconstruct reduction sequences from nodule decortification to core exhaustion (Figure 7; for other examples of analysis based on core reconstruction see Svoboda and Skrdla and Demidenko and Usik). Based on this experience, Van Peer questions whether the kind of analyses used by Boëda would be capable of recognizing change in reduction method during exploitation or of recognizing a recurrent method of production.

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6All references in this section are to papers from the Levallois Conference unless otherwise indicated.
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Figure 5. Comparison of the Levallois and Discoid methods (after Boëda, 1994: Figure 178).
Van Peer recognizes that his argument leads to a quandary as “many Middle Paleolithic assemblages do not allow extensive reconstructions” (p. 8). His solution is to argue for care in the analysis of assemblages that do not refit, which leads to what is ultimately the most contentious issue raised at the Levallois Conference: What is a careful analysis? Dibble forcefully raises the argument that any system of classification must be quantifiable. In his reanalysis of material from the site of Biache St Vaast, an assemblage which is a cornerstone of Boëda’s monograph, Dibble comes to conclusions that differ somewhat from Boëda’s, and is able to support his position based on quantified data. It is worth noting that Dibble does not base his identification of Biache as a Levallois industry on any quantitative data. In fact his quantitative data is only useful once the method has been identified as Levallois.

Experimental knapping of flint, in which processes can be replicated with careful control of various parameters, is fundamental to Boëda’s analyses. It is the experience of knapping in collaboration with his colleagues Jean Michel Geneste and Jacques Pelegrin which led Boëda to the central concepts underlying technological analysis and to the redefinition of the Levallois. Experimental knapping remains a vastly underexploited resource drawn on only tacitly in forming arguments and not drawn fully into the process of analysis. Notably we have almost no quantified observations regarding experimental reference collections (for an important exception see Geneste, 1985). Ohnuma makes this point on the basis of a small study aimed at clarifying the difference between the Levallois and discoid methods. It is remarkable that this is the only experimental study presented at the Levallois Conference.

The chaîne opératoire as defined by Leroi-Gourhan (1993) includes all stages of a technological process from raw material procurement to discard. In the volume from the Levallois

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7Another solution proposed by Sellet is Minimum Nodule Analysis based on grouping together material which appears to come from a single nodule.

8The emphasis on experimental knapping builds on the work of Crabtree, Bordes, and Tixier (Bordes, 1947; Bordes & Crabtree, 1969; Crabtree, 1972; Inizian et al., 1992).
Figure 7. Pattern of flake removals on the flaking surface of the core shown in Figure 2. The sequence is based on the physical refitting of the core. The numbers indicate the position of the removal in the sequence and arrows point in the direction of flaking. Levallois endproducts are indicated by circles and illustrated below. This would be classified as a linear method as only one Levallois flake is removed at each phase of exploitation (Van Peer, 1992: Figure 22).
Conference, most of the authors focus on the stages involved in the knapping of the block of raw material (also true for both the Van Peer and Boëda volumes). A number of authors including Sellet, Kuhn, Henry, and Wengler discuss raw material procurement. Articles by Grimaldi and Lemorini and Shea present the results of use wear analyses which address the function of Levallois flakes in Italy and the Levant.

Discreteness of methods
A central tenet of Boëda’s approach is that there will be no redundancy in knapping methods used in a given assemblage. Only one method will be used in an assemblage unless multiple methods are used to arrive at different objectives. Furthermore Boëda argues that the knapper has little flexibility to change methods in the course of knapping. Certainly, adoption of these tenets simplifies the job of the analyst. However, a number of contributors to the volume from the Levallois Conference provide evidence which indicates a greater degree of flexibility. These arguments tend to focus on flexibility within the reduction sequence of a single nodule. As mentioned above, Dibble reanalyzed the Biache St Vaast material and found that exploitation moved from a unidirectional or bidirectional recurrent Levallois exploitation to a sub-radial pattern of exploitation. Similar results were reached by Texier and Francisco-Ortega based on the site of Berigoule, and by Bietti and Grimaldi based on sites from central Italy. In her analysis of material from the Abri Suard, Delagnes found that despite a maintenance of a unidirectional recurrent Levallois exploitation, the location of the striking platform shifted during the course of reduction.

A number of articles in the Levallois Conference volume question the discreteness of the Levallois method. Lenoir and Turq and Ohnuma question the discreteness of Levallois method from the Discoid method. These authors are following Bordes who had argued that Discoid cores represent the terminal phase of Levallois exploitation. Farizy and Jaubert strongly disagree with this assessment and bring examples of the use of the discoid method from sites in Greece, Spain, and France. There is some confusion here between the definition of Levallois as a method and the typological description of certain cores as Levallois. Boëda is not arguing about the morphology of exhausted cores (which due to accidents could take on a great variety of forms) but about the spatial model that guided knapping. It has yet to be demonstrated that shifting back and forth between Levallois and Discoid methods is a viable strategy.

In his article on the Pontian industry of Italy, Kuhn raises the question of defining the limit of the Levallois. Kuhn asks whether a method that does not involve initial core preparation, but in which the nodules are chosen such as to already possess the form of a Levallois core, fits under the definition of Levallois. The particular industry Kuhn is discussing exploits extremely small nodules (mean core length 3 cm) such that it would have been difficult to actually shape the core volume. The same issue is raised by Delagnes and Farizy and Jaubert. It would seem that, following Boëda’s criteria, the answer would be that this industry is Levallois as criteria 3 says only that the two faces need to be organized in terms of convexities, not shaped.

Several authors discuss the relationship between the Levallois method and biface manufacture, stressing the morphological similarity between Levallois cores and bifaces. Rolland and Tuffreau argue that the Levallois method actually developed from biface manufacture. In an important contribution Loraine Copeland looks at the evidence for the Levallois method in the

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9This is a theme which is also touched on by Meignen, Marks and Monigal, and Van Peer on the basis of unidirectional industries.
Acheulian of the Near East and asks whether the typologically Levallois flake are not by-products of biface manufacture. Copeland has illustrated the importance of clarifying whether the presence of Levallois flakes is actually evidence for use of the Levallois method.

Technology and genealogy

In evolutionary biology, cladists have made a strong argument for the strength of classification based on genealogy or patterns of descent. It does not flow from this success that all classification should mimic cladistics. The strength of a system of classification lies in its ability to provide a meaningful scaffold for analyses. Technological analysis succeeds in this regard where other approaches have failed. It is not that other approaches do not provide a framework, but rather that there is a lack of a concrete connection between the framework and the process by which the assemblage was created. The strength of the technological approach is that it has forged such a linkage based on the recognition of the mental constructs and physical actions which allow the flint knapper to control the reduction of a nodule of flint into useful tools. Like cladists, technologists have found the touchstone on which to build their classificatory system. Species are produced by descent with modification thus cladists argue that a classificatory system for biological organisms must be strictly genealogical. Stone tool assemblages are made by humans living as members of a community employing learned knowledge and skill. Cladistics and technology are similar in their epistemology but not in their content. The difference between the two systems is due to the difference between organisms and artefacts.

The recognition of this difference leads to the conclusion that, while in cladistics genealogical determination is the basis of classification, for technological analysis genealogical determination is a secondary analytical goal. It is only by combining the results of technological analysis with chronostratigraphic data that one can advance scenarios concerning the genealogical relationships of assemblages. Of course what one is actually advancing are hypotheses concerning the spread of ideas through learning.

Rolland has boldly attempted such a genealogical scenario for the Levallois but the results indicate that this undertaking is probably premature. As Rolland recognizes, the determination of technological criteria is based on publications in which assemblages are treated typologically is difficult. A similar problem is faced by Vermeersch who attempts to plot the geographical distribution of Levallois in North Africa. Tuffreau is in a much stronger position in his discussion of Northern France which has been the focal point of technological analysis and for which there is a detailed chronostratigraphic record. On the basis of a series of well dated sites Tuffreau proposes that there is clear evidence for use of the Levallois method during oxygen isotope stages 8–6 with an increased diversification of methods, including non-Levallois blade methods, during stages 5–4. Meignen is on similarly solid ground in her discussion of the Middle Paleolithic of the Levant. One of the exciting components of the Levallois volume is a series of articles discussing the evidence from areas where the record is just beginning to emerge including Anatolia (Yalçinkay), Mongolia (Derevianko & Petrin), the Altai (Derevianko & Markin), and Japan. In each of these cases only preliminary inferences can be made in part because much of the material comes from surface collections. As Sato, Nishiaki and Suzuki make clear, this situation is beginning to change for Japan with important implications.

The danger of a non-contextualized approach to the Levallois is discussed in a paper by Otte.
Conclusions

Within the context of the study of human evolution the question remains of how the adoption of a technological approach affects the relationship between the biological systematics of hominid fossils and the archaeological systematics of stone tool assemblages. Technological analysis highlights the differences between artefacts and organisms. Ultimately technological analysis involves systematics of learned patterns of behavior. The distinction between behavioral and biological systematics rests on the differences between reproduction and learning. As Sally Binford pointed out over 20 years ago, stone tools don’t mate. The technologists through a combination of creativity, experimentation, and tenacity have begun to show us how to make this observation the core of a new approach to lithic analysis.

Acknowledgements

I would like to thank the members of the URA 28 of the CNRS for their welcome during my time in Meudon during 1992/1993, the Foundation Fyssen for funding, and the Maison Suger for providing ideal living conditions. I am particularly grateful to Éric Boëda and Jacques Pelegrin, and hope that I have expressed their ideas fairly and accurately. This review was written while I was an associate of the Peabody Museum of Harvard University. I would like to thank Ofer Bar-Yosef for his generosity and encouragement.

References


